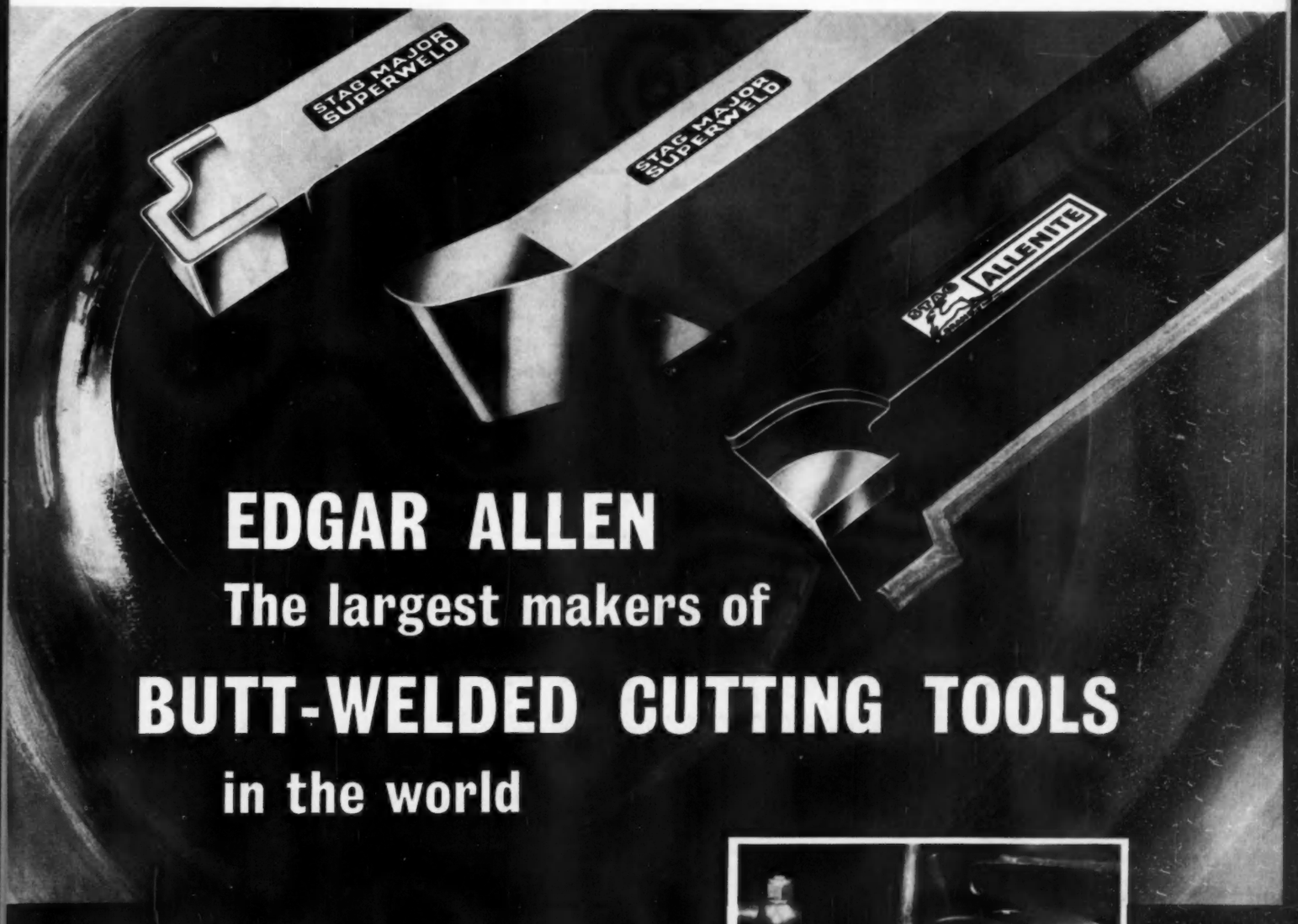
THE ENGINEER

OCTOBER 14, 1960 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS



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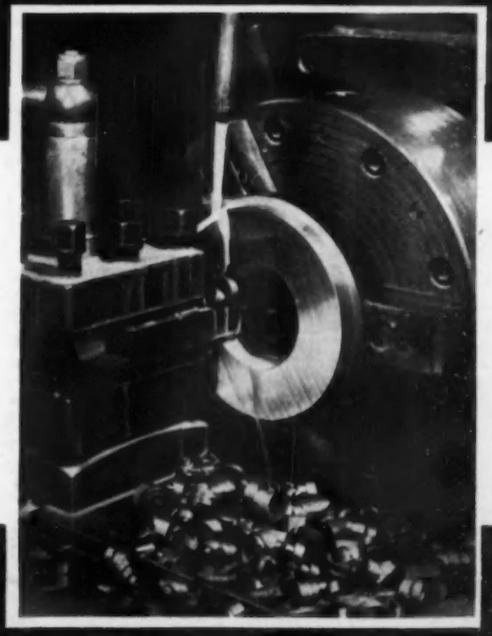

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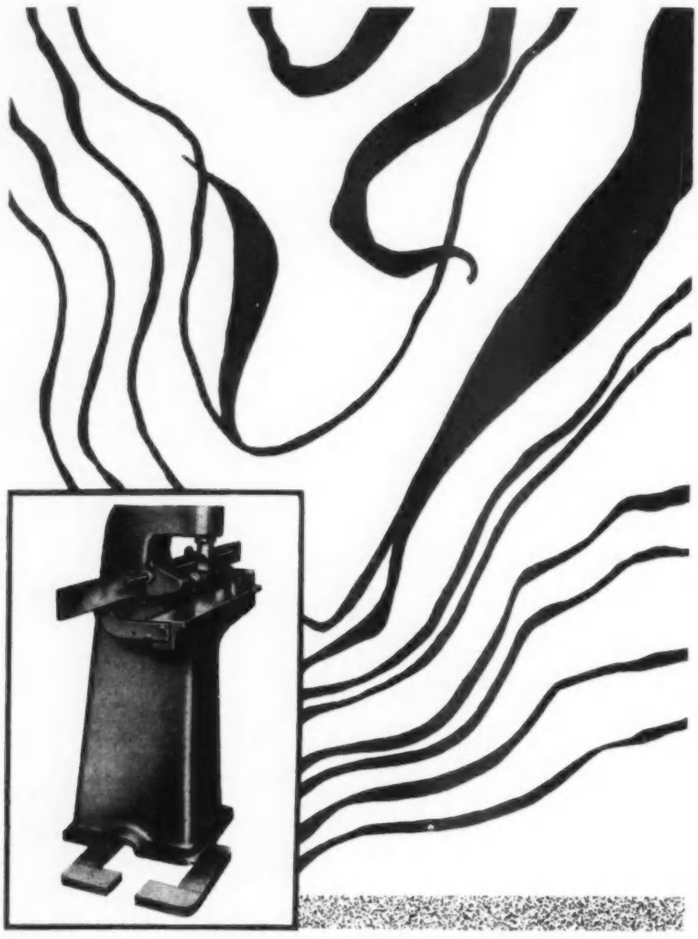

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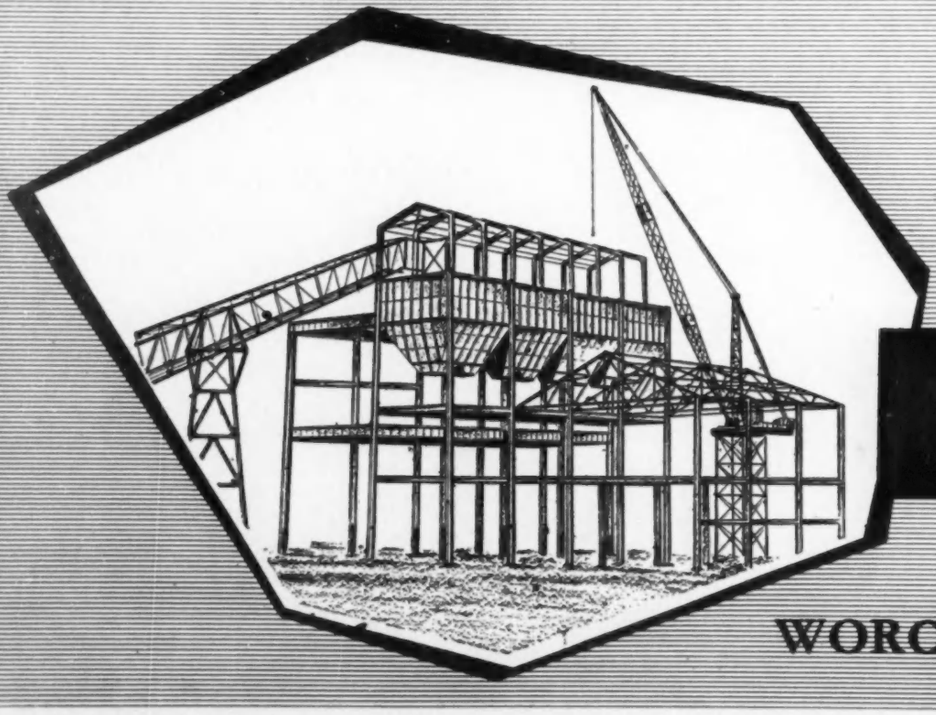

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THE ENGINEER

Established 1856

No. 5464 **OCTOBER 14, 1960** VOL. 210

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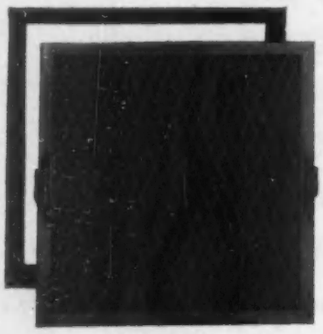

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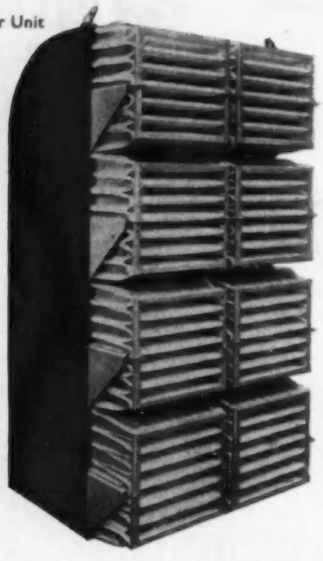
VISCO 'MV' Dry Type Air Filter Unit



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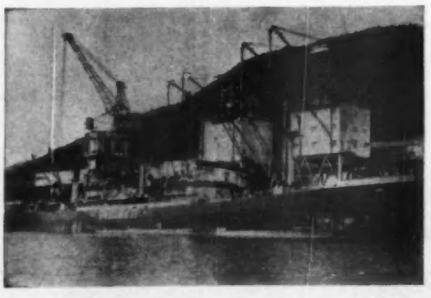

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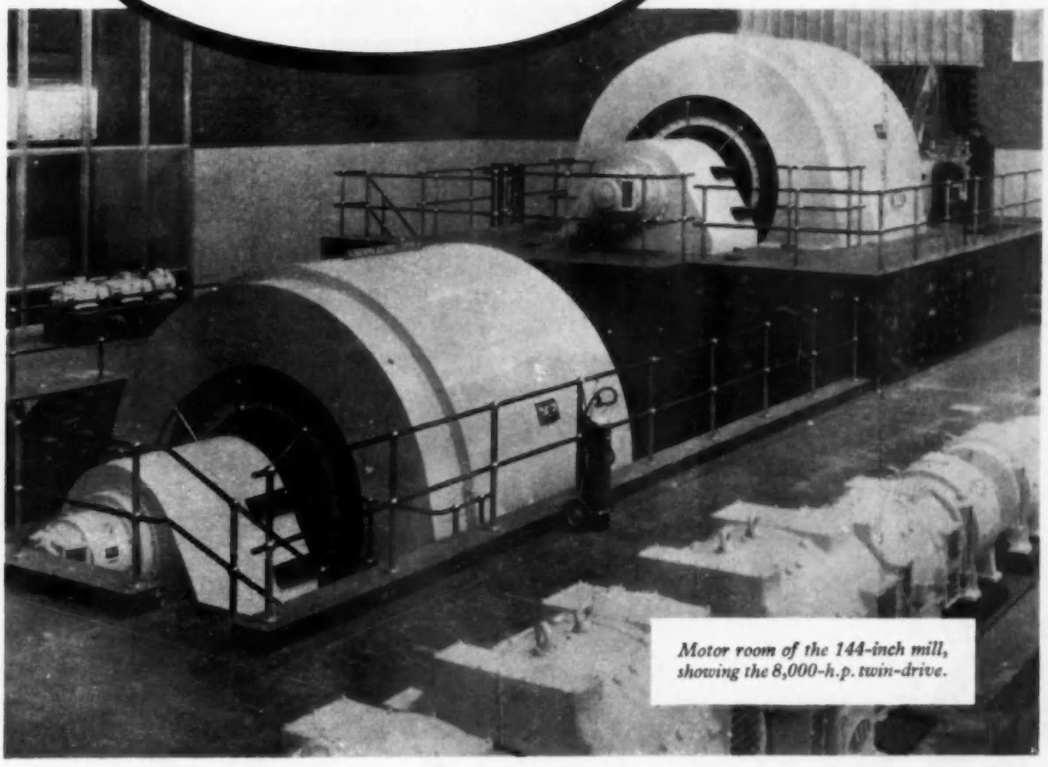

Motor room of the 144-inch mill, showing the 8,000-h.p. twin-drive.

For the expansion scheme at Rogerstone Works, AEI have supplied to Alcan Industries Limited (formerly Northern Aluminium Co. Ltd.) all the electrical equipment for the new 144-inch hot reversing mill and for the modernisation and enlargement of the 88-inch hot-finishing mill.

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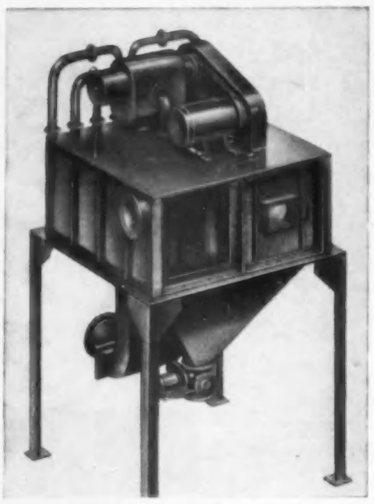

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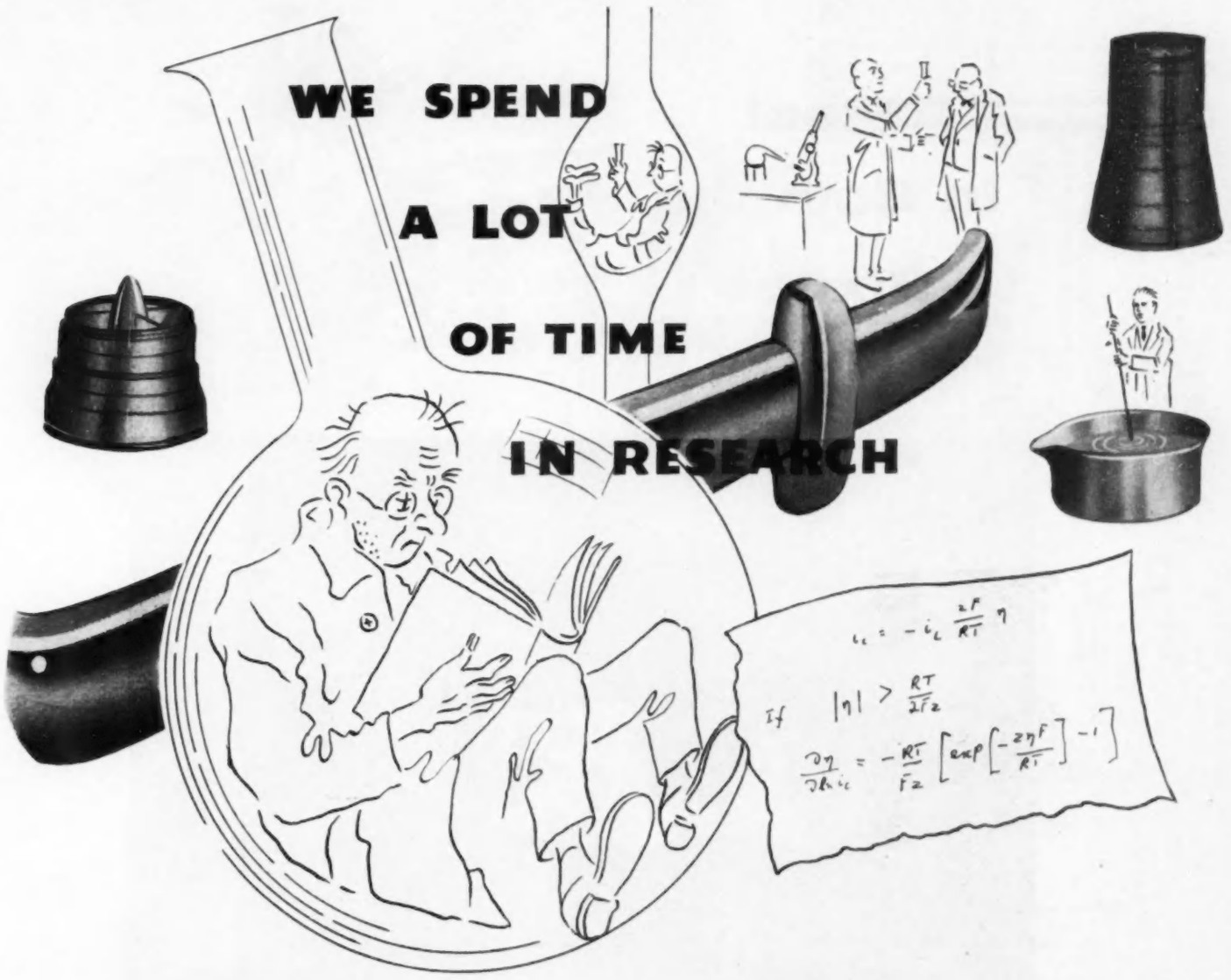

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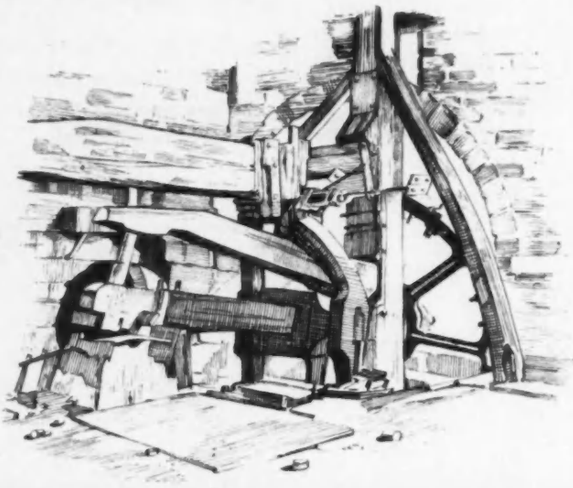

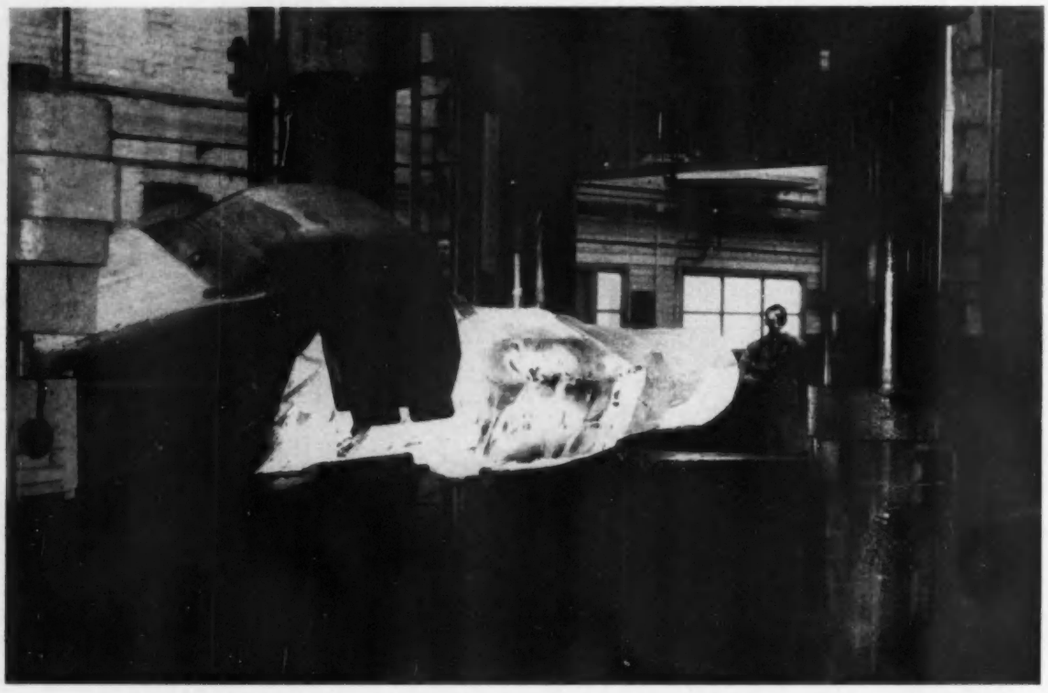

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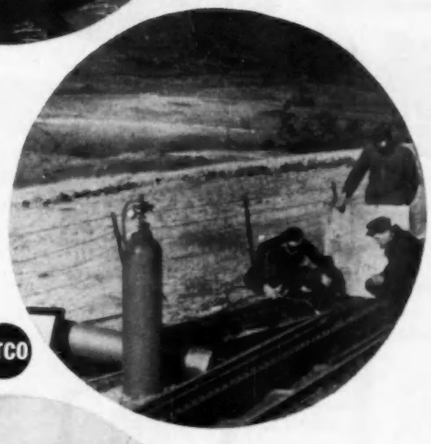

Oxy-acetylene rail re-surfacing on Snowdon's Mountain Railway. *(With acknowledgements to British Oxygen Gases Ltd.)*

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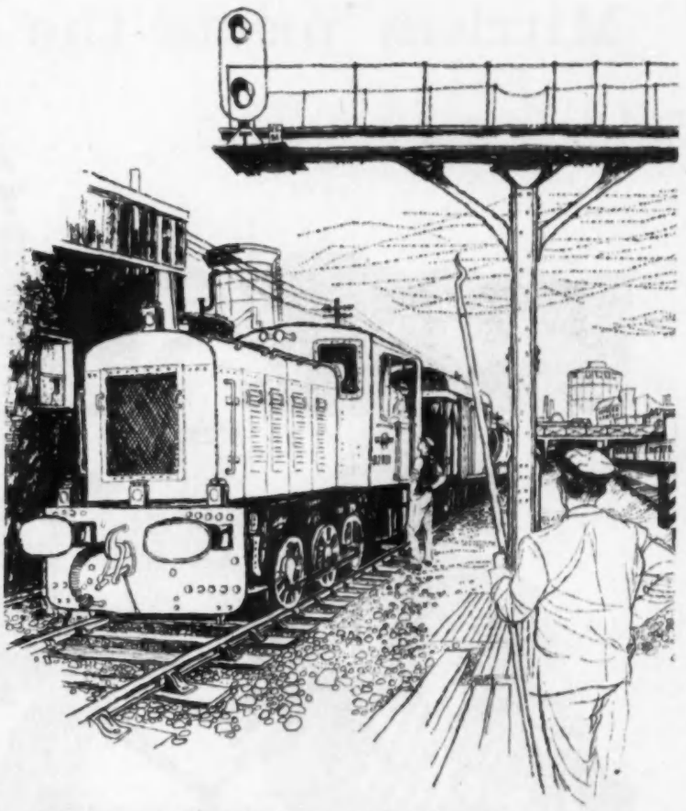

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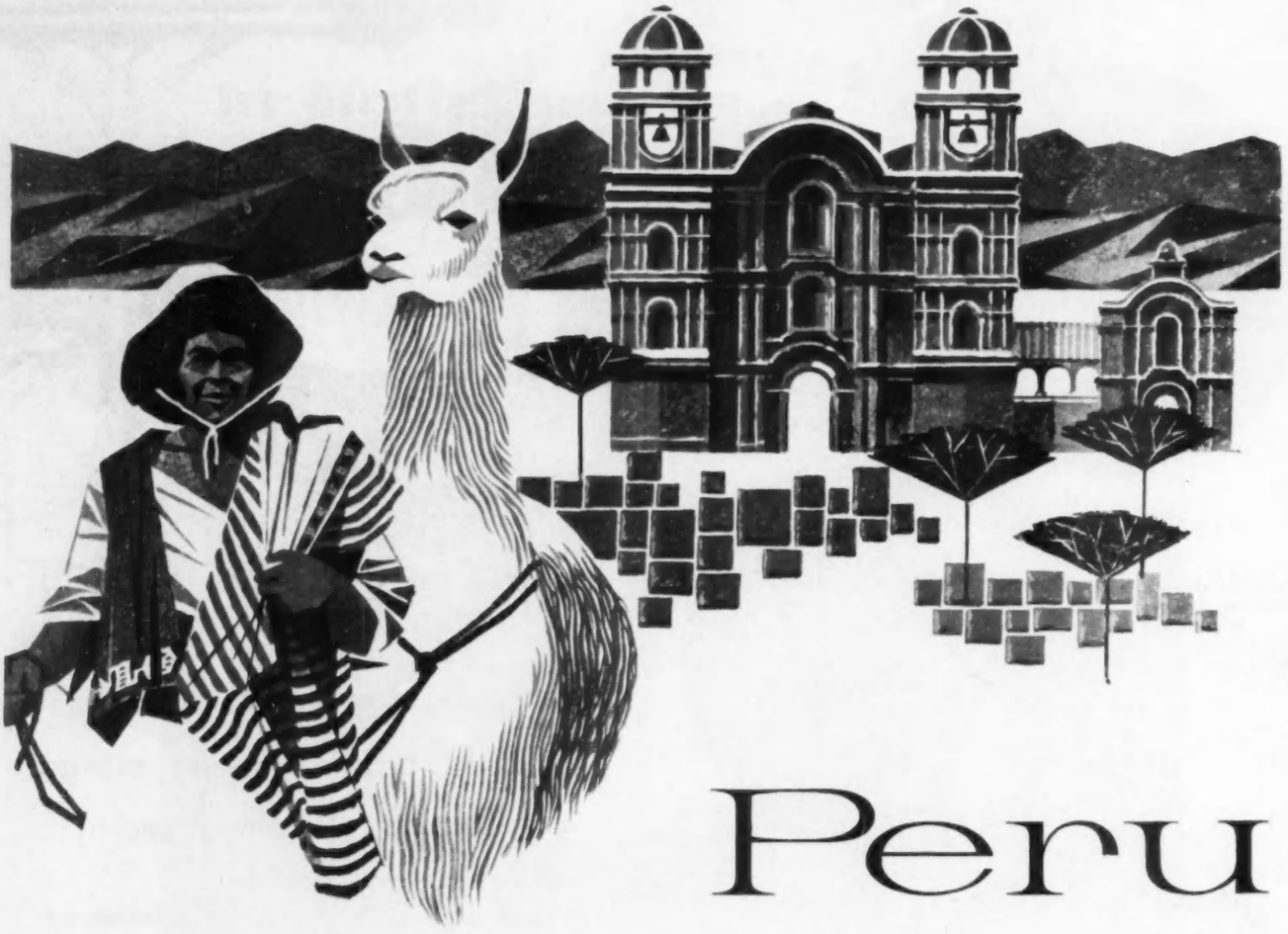
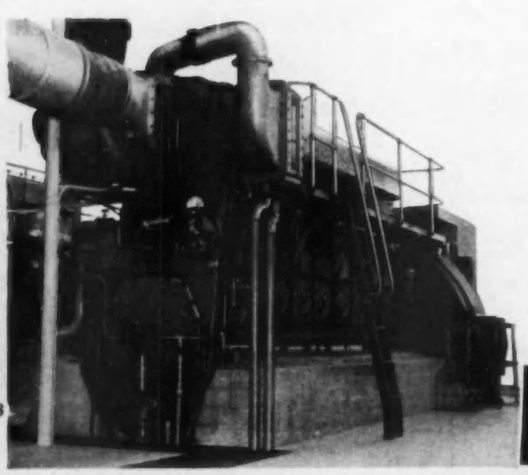


Peru

Over the last three years Mirrlees have supplied to N.V. Overzeese Gas-En Electriciteit-maatschappij of Rotterdam a total of 20,064 h.p. produced by K type engines. Of these three KS8 generating sets have been installed at Piura in Peru, South America. Each engine is site rated for an output of 1,920 b.h.p. continuously at 400 r.p.m. and capable of a 10% overload of 2,112 b.h.p. for one hour.



One of the three KS8 engines installed at Piura, Peru.

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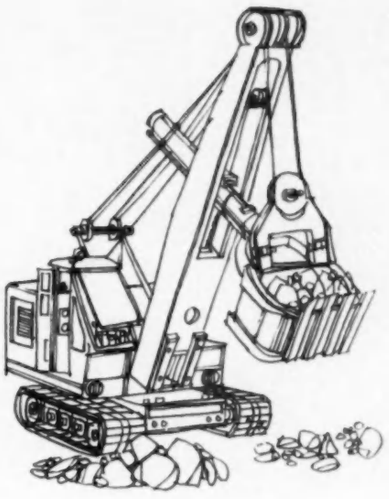

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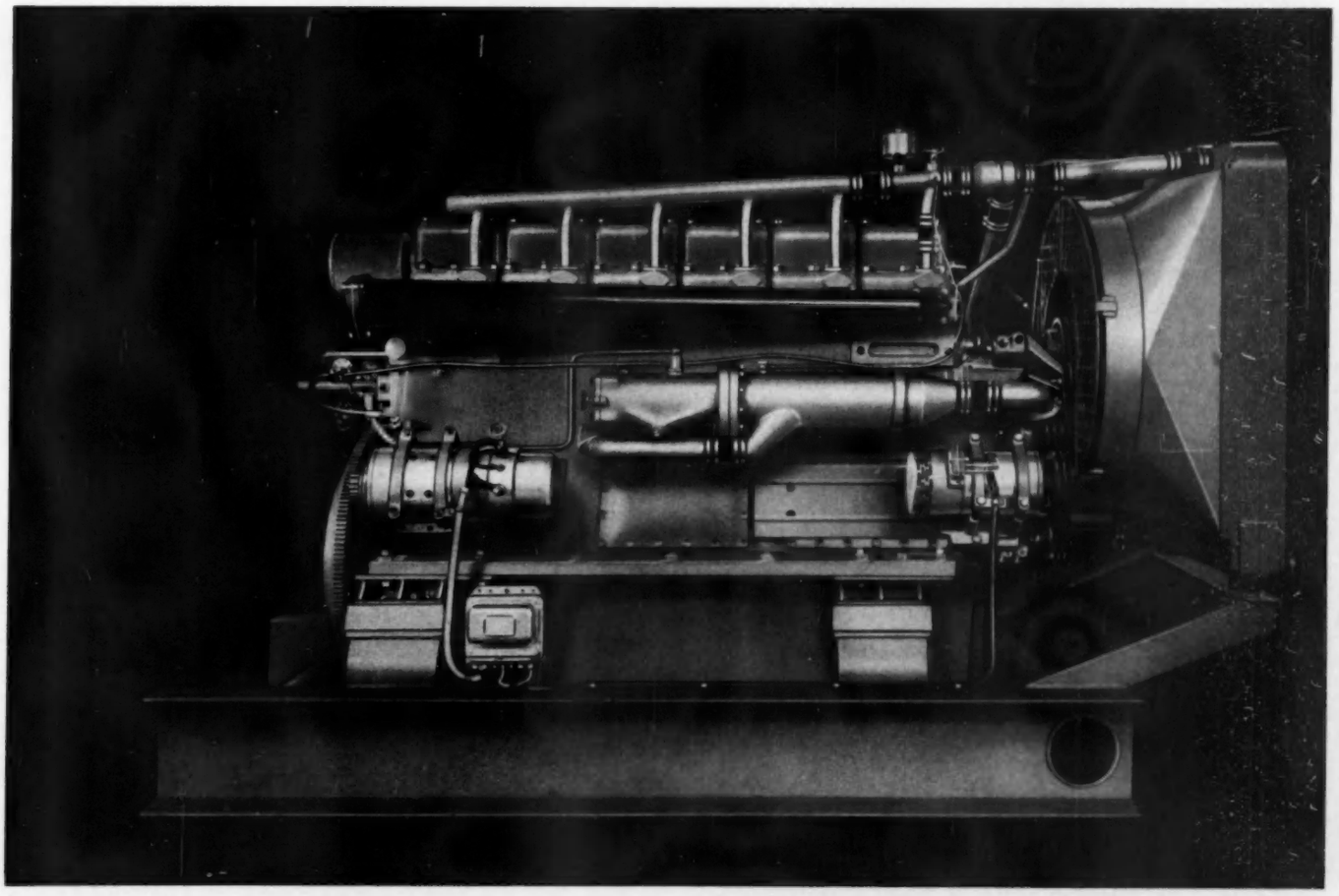

MERCEDES-BENZ DIESEL

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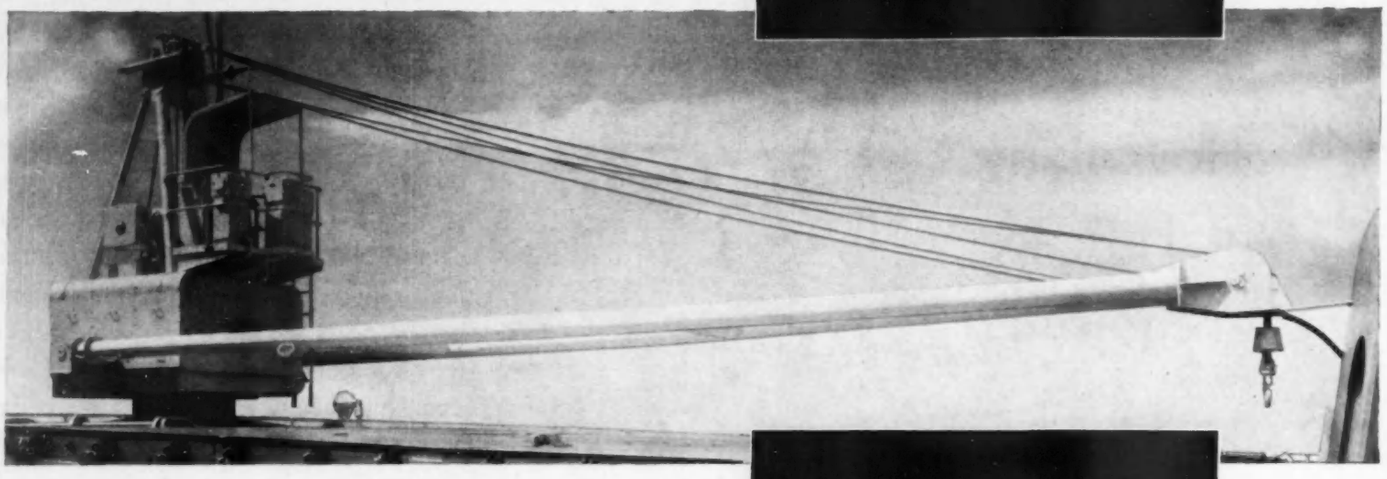

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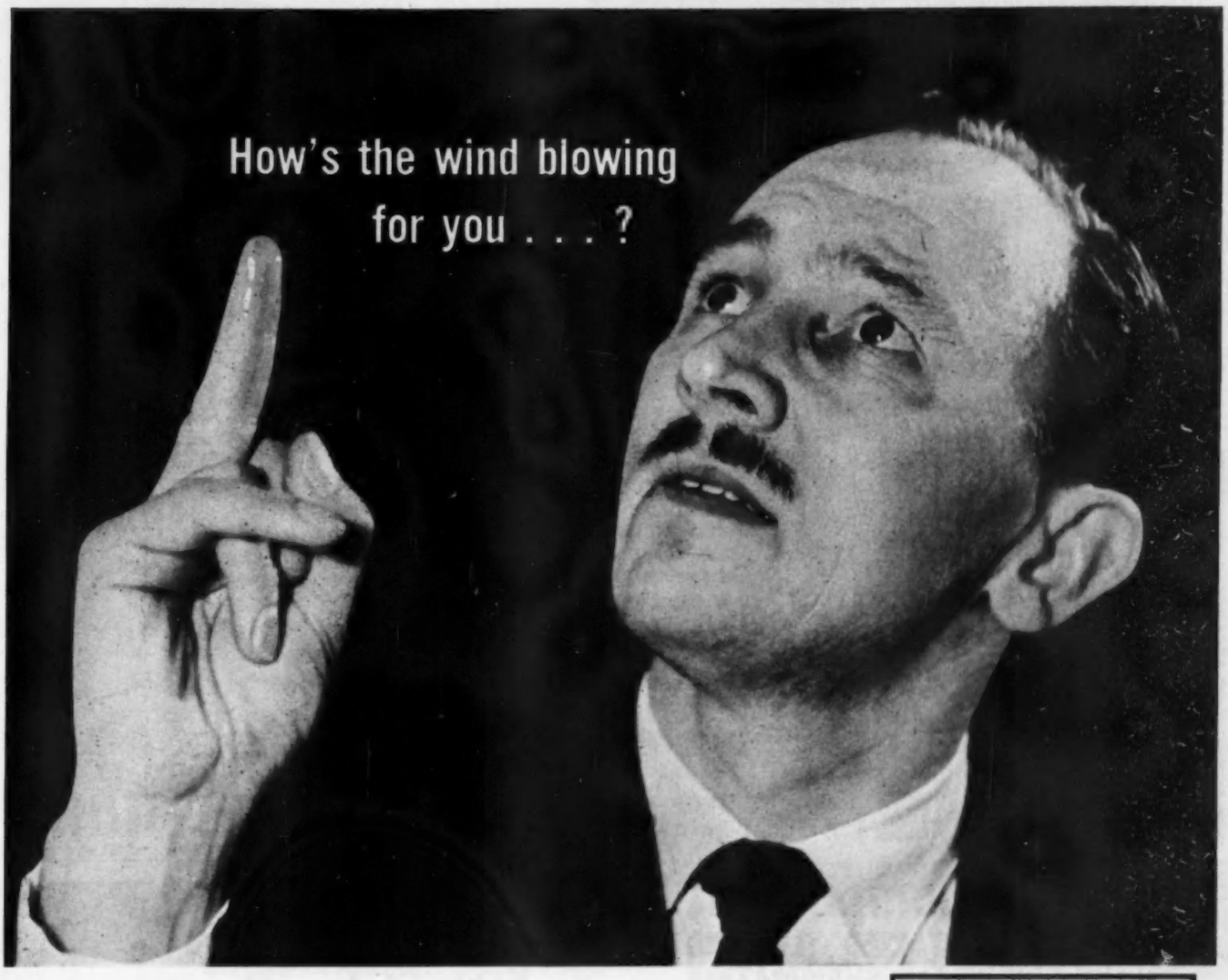

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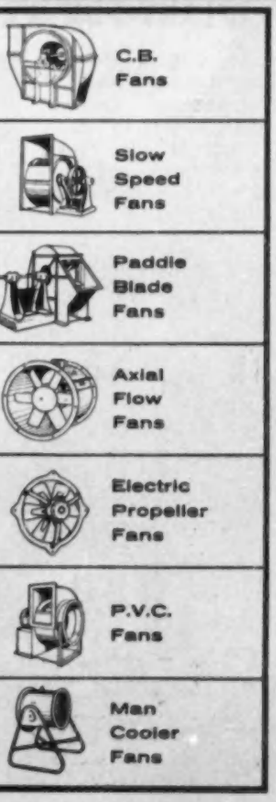

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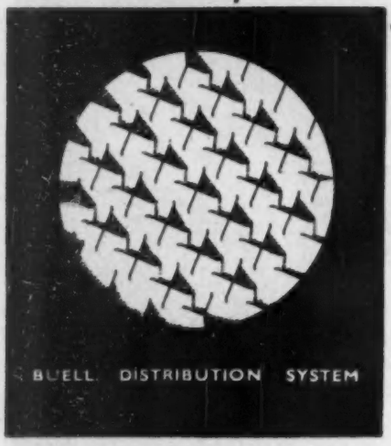

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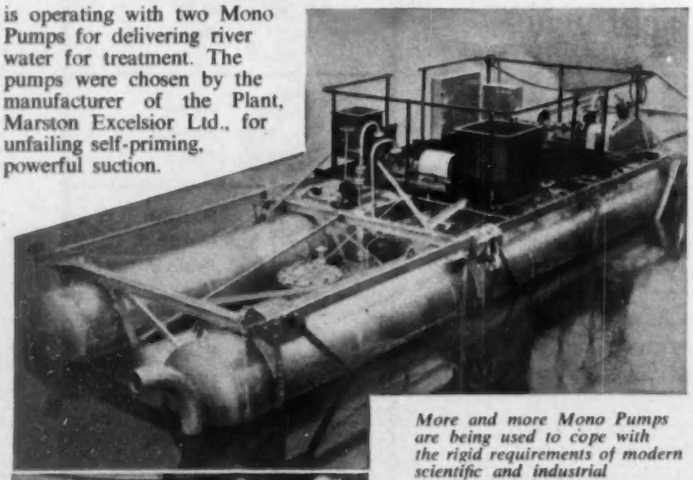

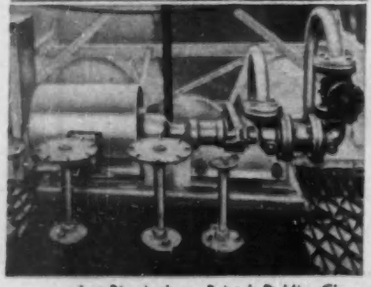

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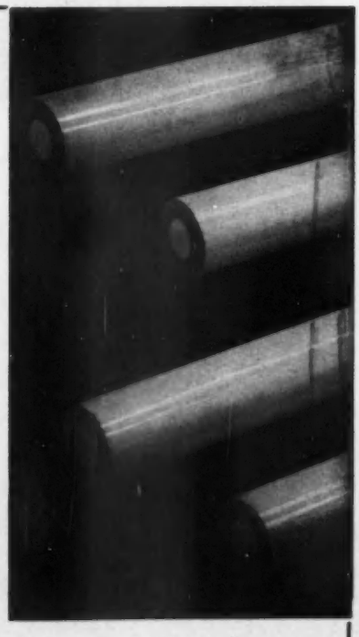

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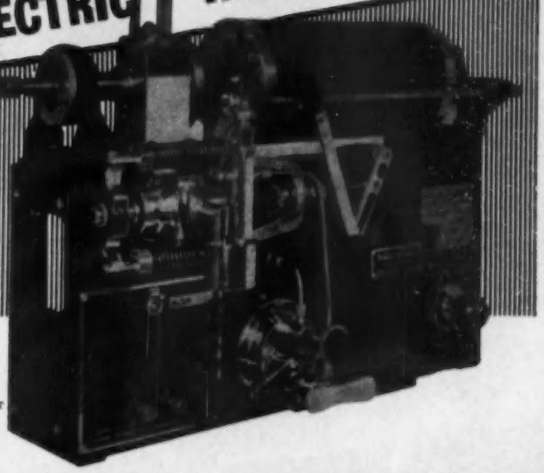

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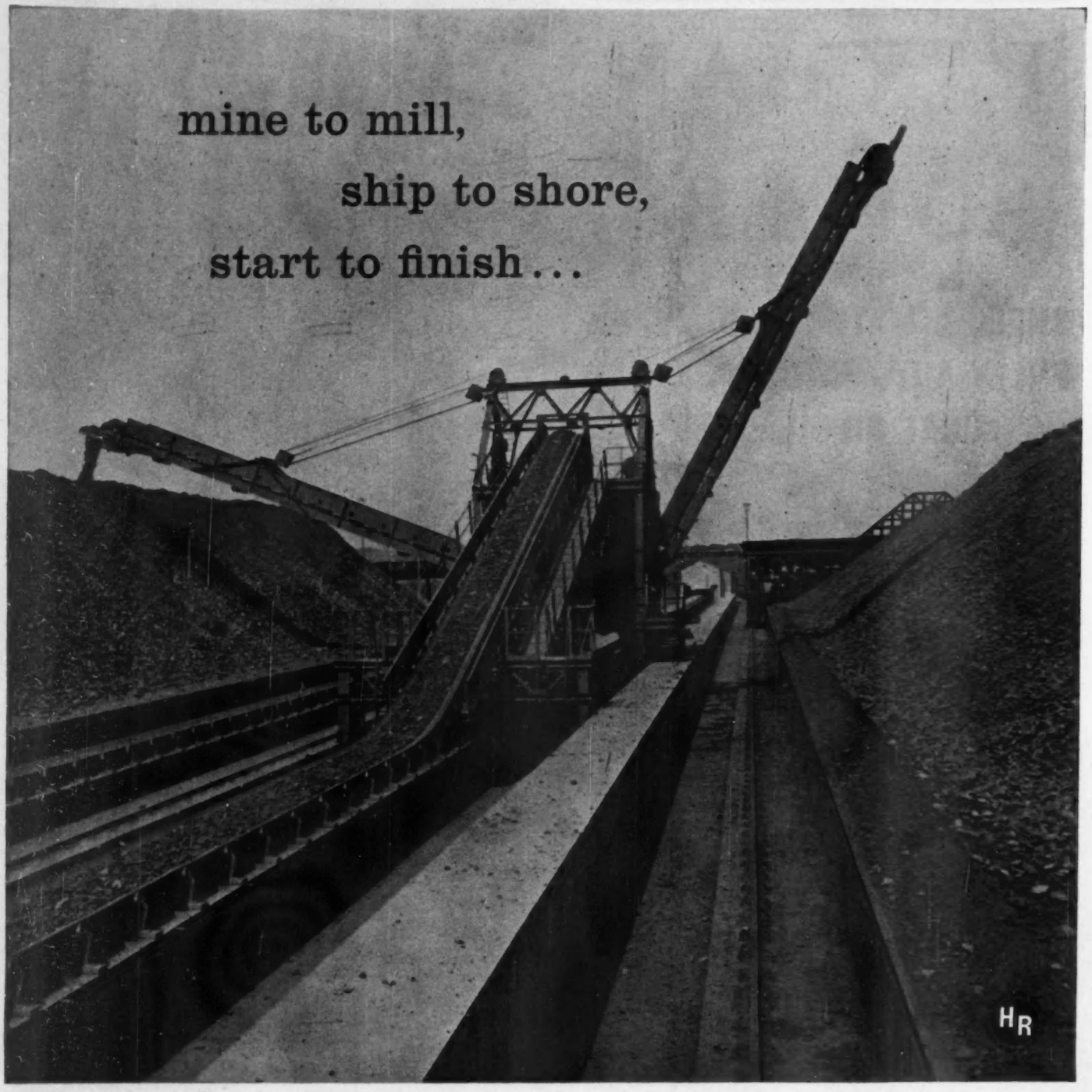

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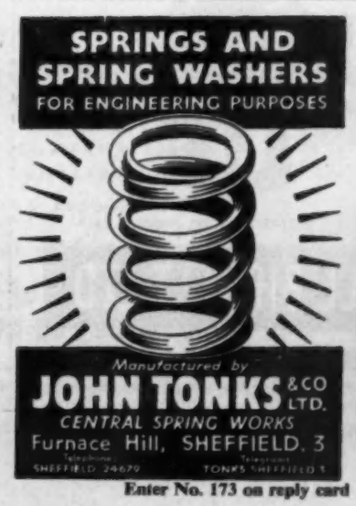

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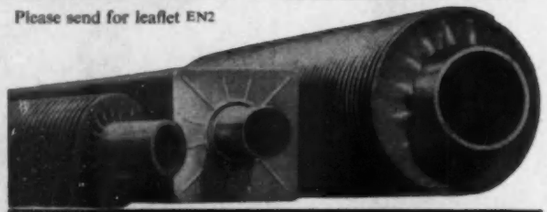

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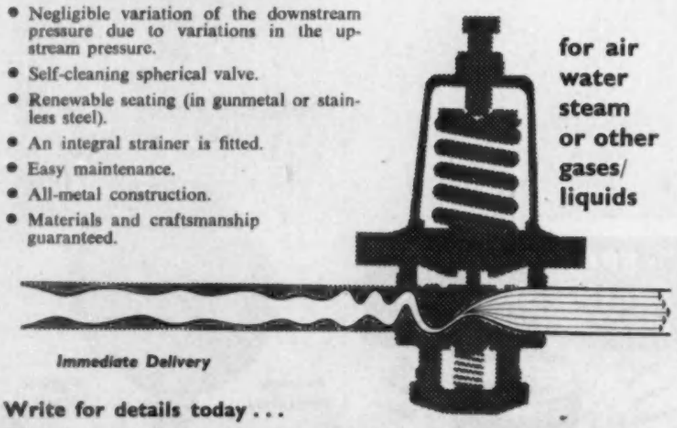

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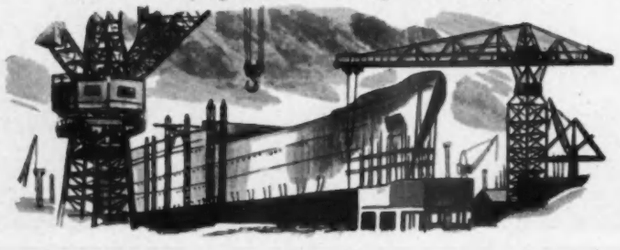

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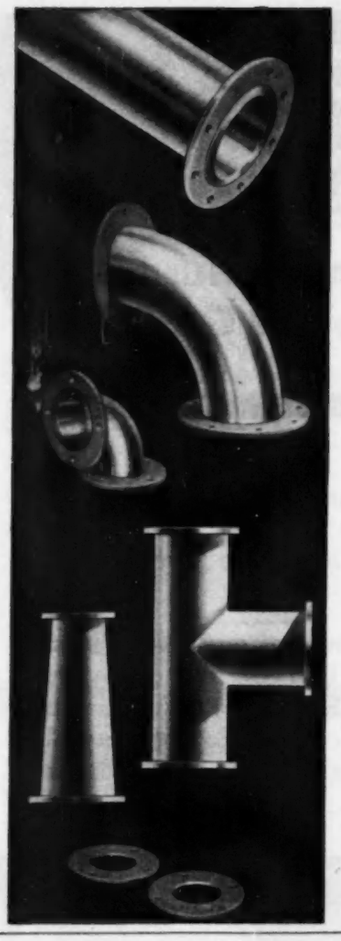

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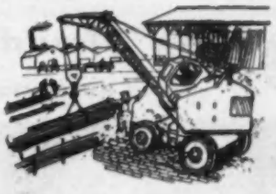

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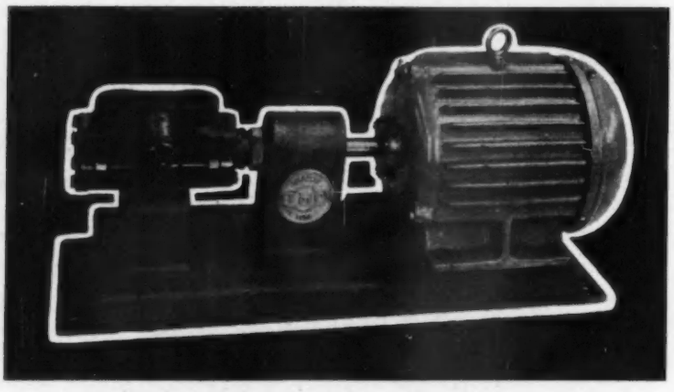

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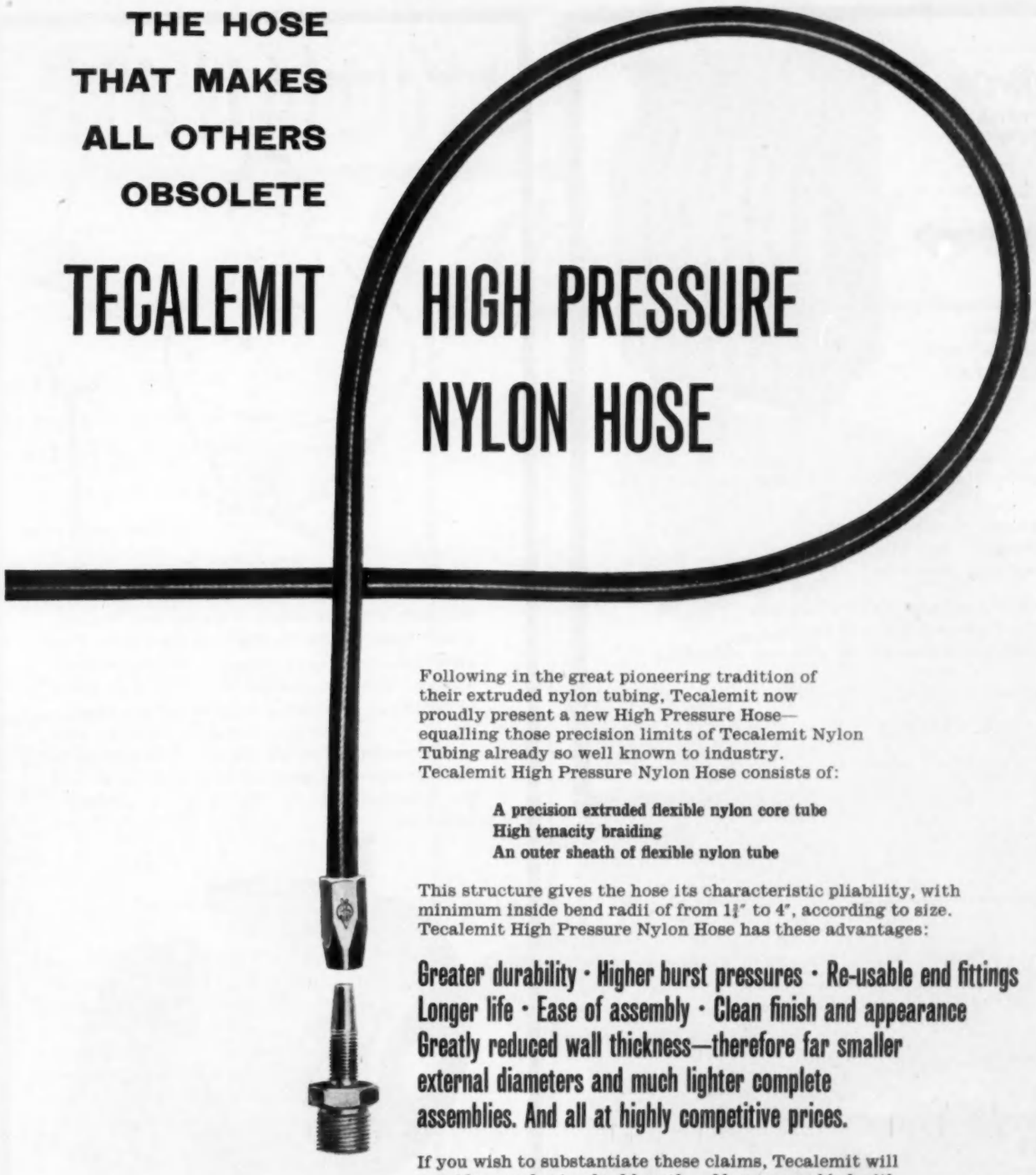

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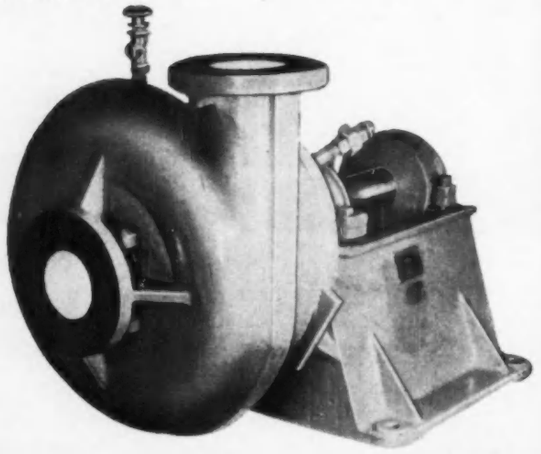

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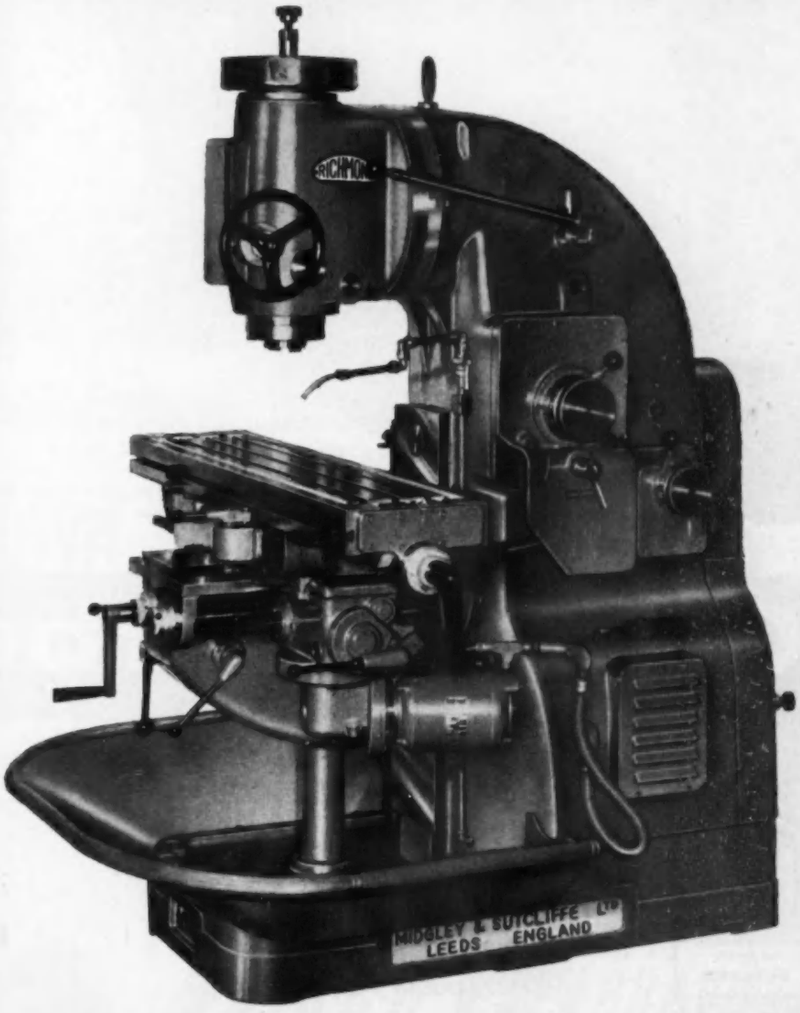

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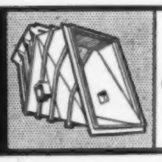

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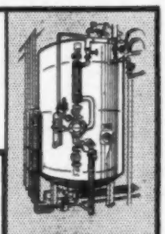

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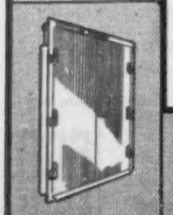

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DESUPERHEATERS, AUTOCLAVES.
HIGH VACUUM VESSELS,
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GENERAL FABRICATION
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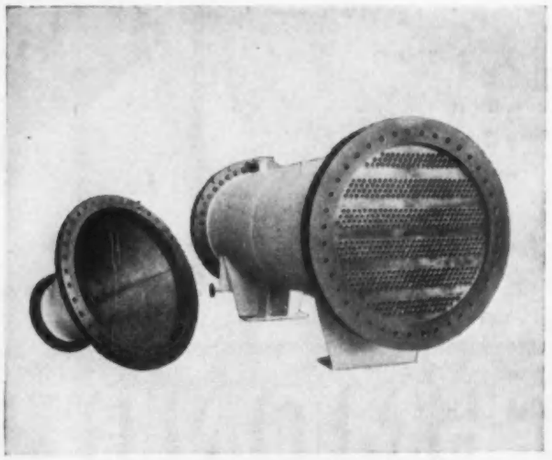
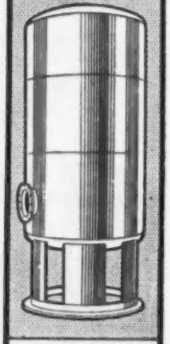
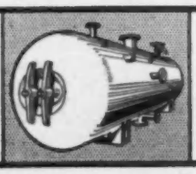


One of a number of specially constructed Heat Exchangers

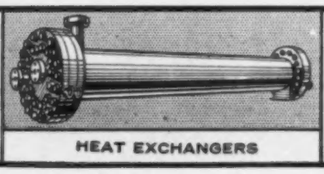


STORAGE TANKS

HYDRAULIC PRESSINGS

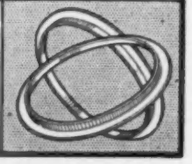


PRESSURE VESSELS



HEAT EXCHANGERS

ROLLED AND PROFILED FLANGE RINGS



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The "Margam Abbey"—built for the Port Talbot Pilotage Authority by Richard Ironworks Ltd., in which Cor-Ten was used extensively. Photograph by courtesy of the Port Talbot Pilotage Authority

COR-TEN GOES DOWN TO THE SEA IN SHIPS

At sea as well as ashore new uses are constantly being found for SCW Cor-Ten. It was used extensively in the construction of this vessel for the Port Talbot Pilotage Authority.

The Main Deck and Bulwark Plating
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—were made entirely from Cor-Ten. A typical example of the growing use of Cor-Ten in marine construction, and in other fields where high yield strength, together with outstanding resistance to corrosion, is vital.

COR-TEN IS TOUGHER

Weight for weight, the yield strength of SCW Cor-Ten is 50% higher than ordinary mild steel.
Alternatively—
Strength for strength, a saving of 1/3 of the weight is possible.

4-6 times more resistant to atmospheric corrosion.
Highly resistant to abrasion and fatigue.

COR-TEN SAVES MONEY

Initial costs are spread over a longer service life.

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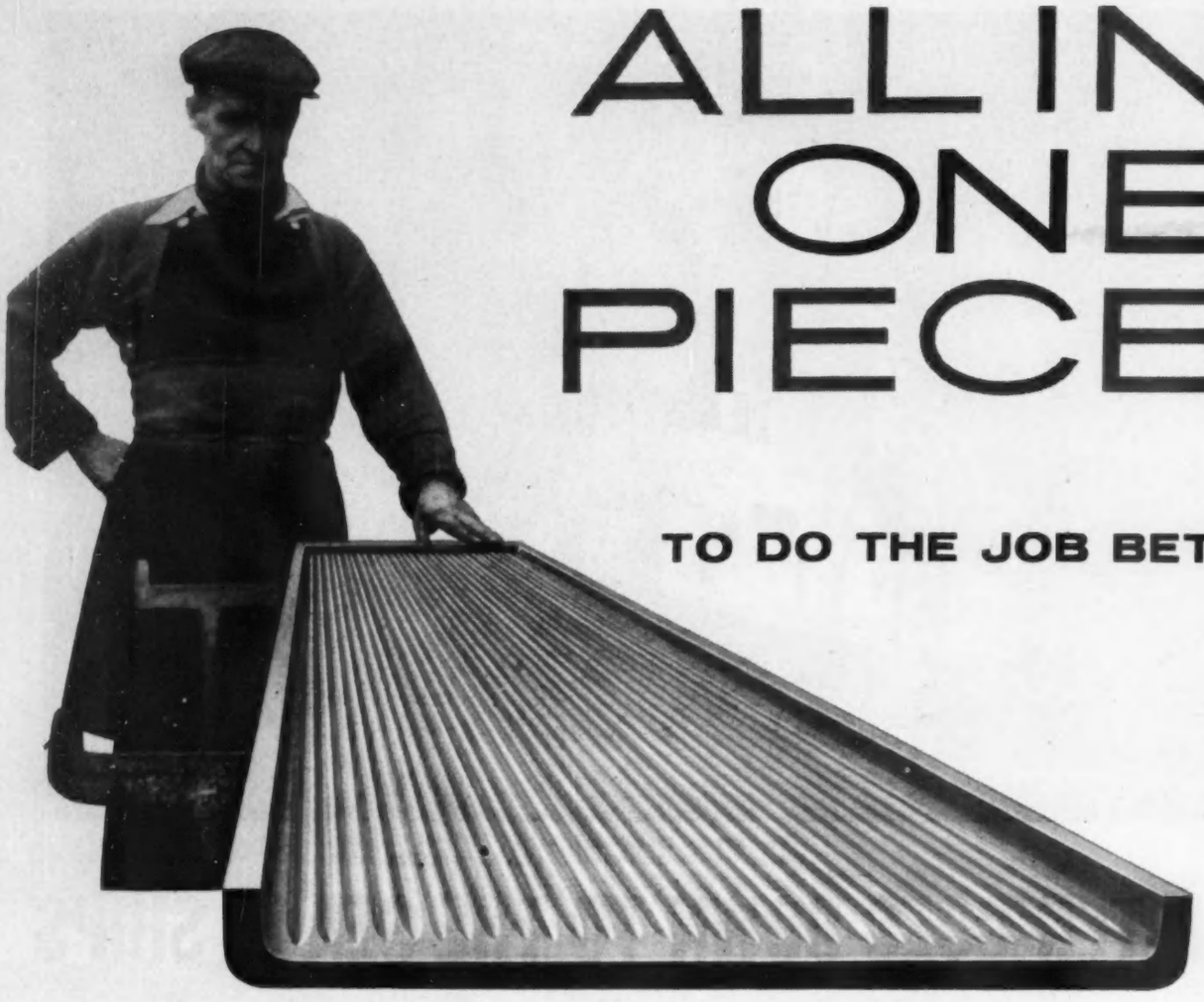

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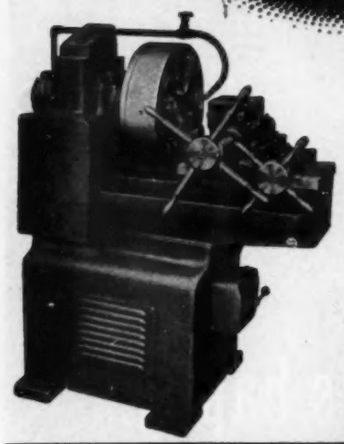

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A general purpose machine, capable of handling a wide variety of Pipe and Bolt work at a very low die cost. Tangential Die Head with quick opening and closing device, . . . no nuts to unscrew.
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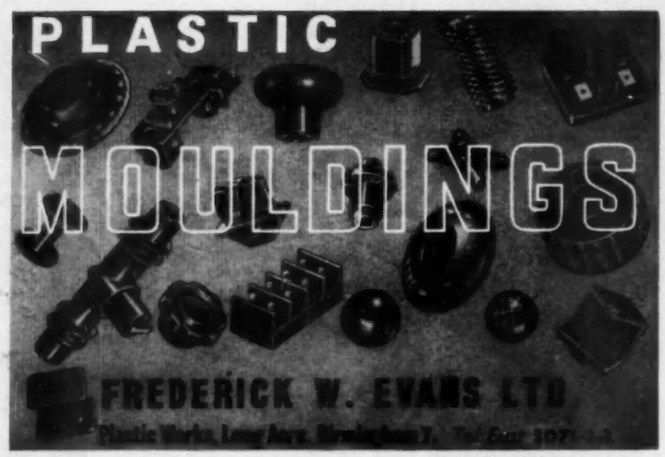

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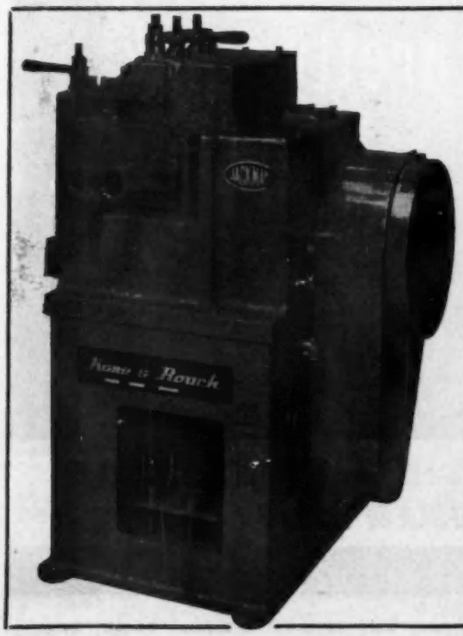

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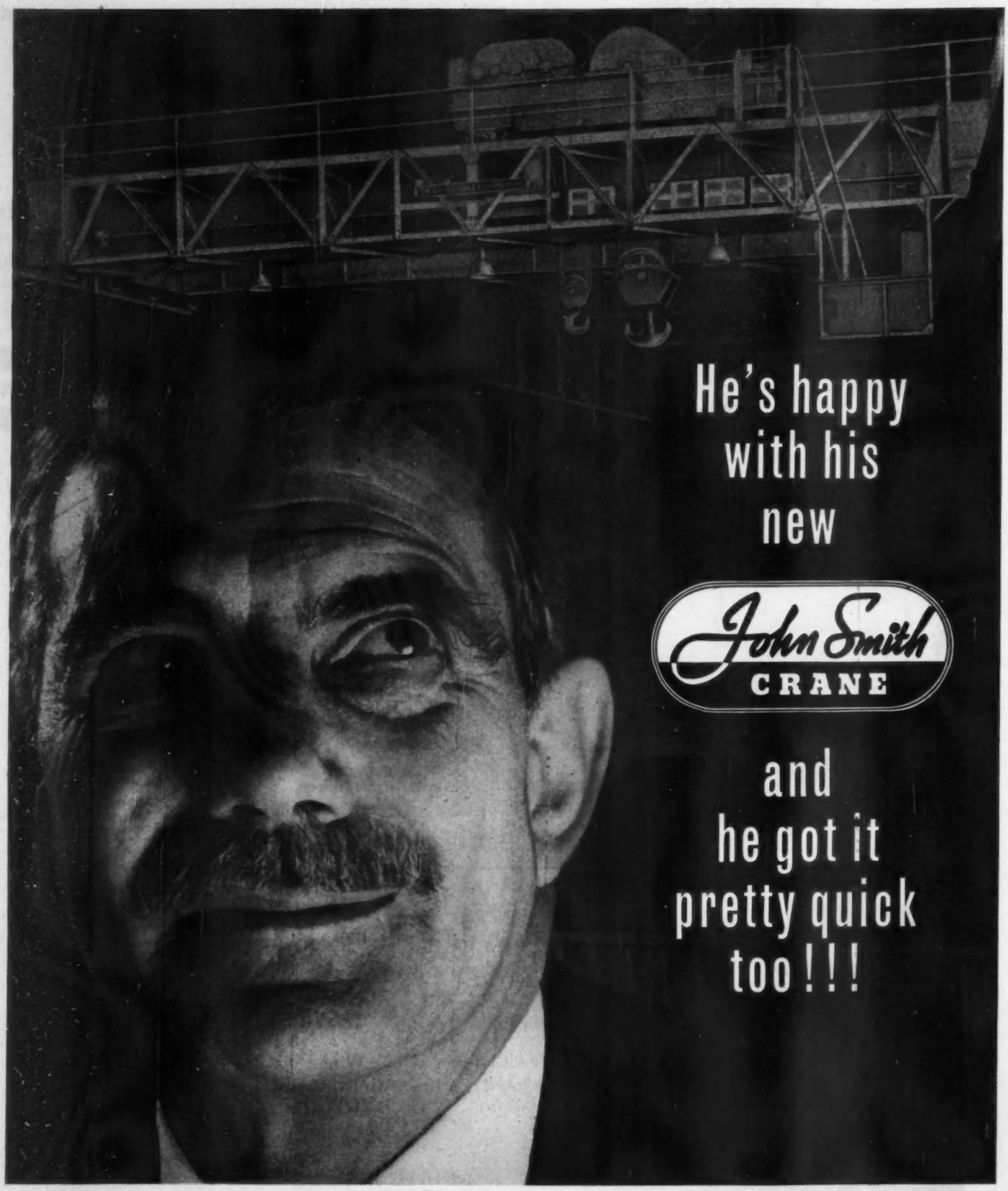

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give Birmingham's Inner Ring Road a new high standard of illumination

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An overall light intensity of at least 30,000 lumens was specified for the new road, this from lanterns spaced at 100 ft. intervals on the outer kerbs. To achieve this, Sir Herbert J. Manzoni, C.B.E., the City Engineer and Surveyor, called in the G.E.C. Lighting Division to develop his design for a new type of post-top lantern housing three 400w colour corrected mercury lamps.

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The specially designed post-top lanterns are 4 ft. 6 ins. in diameter, approximately 18 ins. deep, and consists of a domed canopy and dished translucent Perspex bowl. Access to the three Osram 400w colour corrected mercury lamps is remarkably simple. The 30 ft. high slender steel poles are made by Stewarts & Lloyds.

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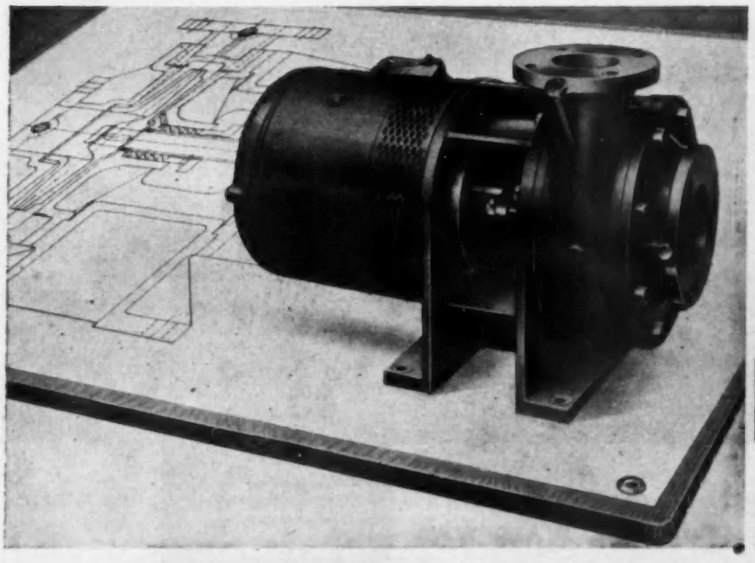

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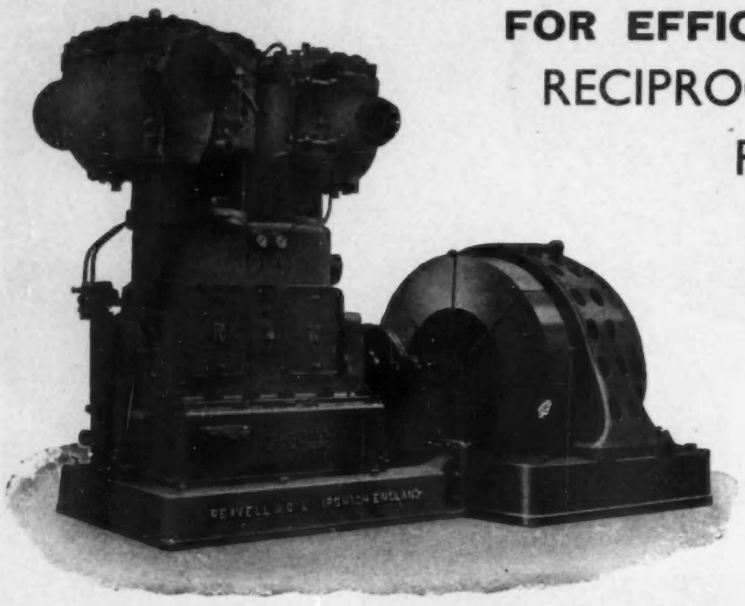

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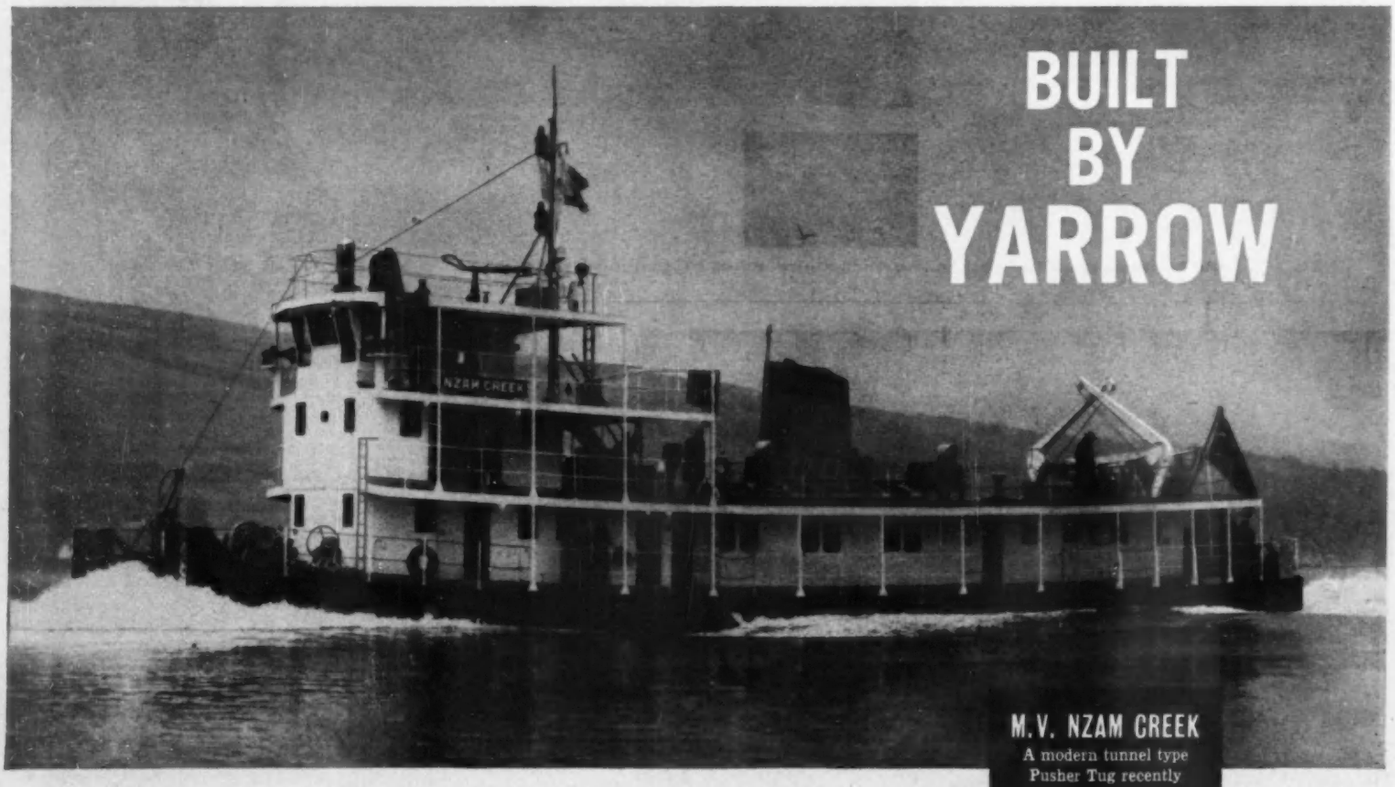

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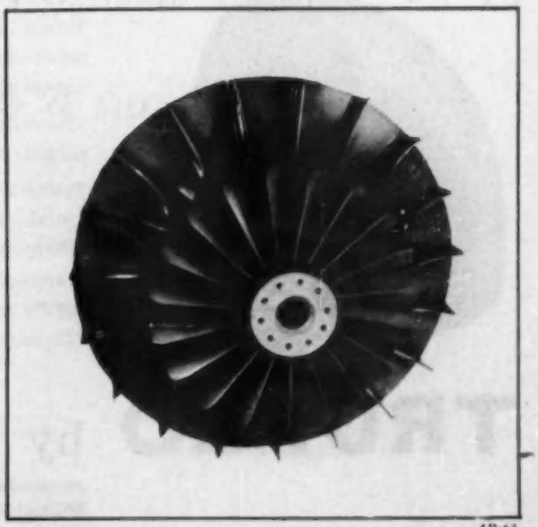

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Truflo fittings conform to the dimensional requirements of American standards ASA.B36.19 and MSS.SP-43 for schedule 5s and 10s wall thicknesses and ASA.B16.9 for schedule 40s and greater. British standard BS.1640 also applies, and in all cases materials conform to ASTM.A.312 and A.403 (stainless) and ASTM.B127 and B162 (nickel alloy).

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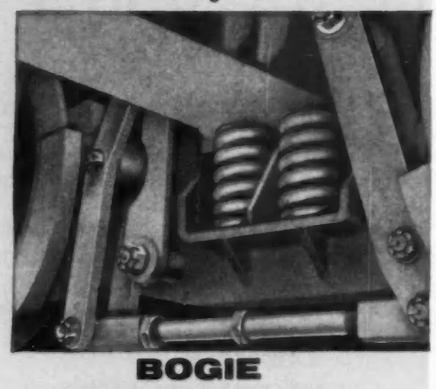
All gearing is totally enclosed in cast steel gearboxes. These house accurately machine-cut steel spur gears constantly enveloped in a protective oil film, coupled to independently mounted electric motors.



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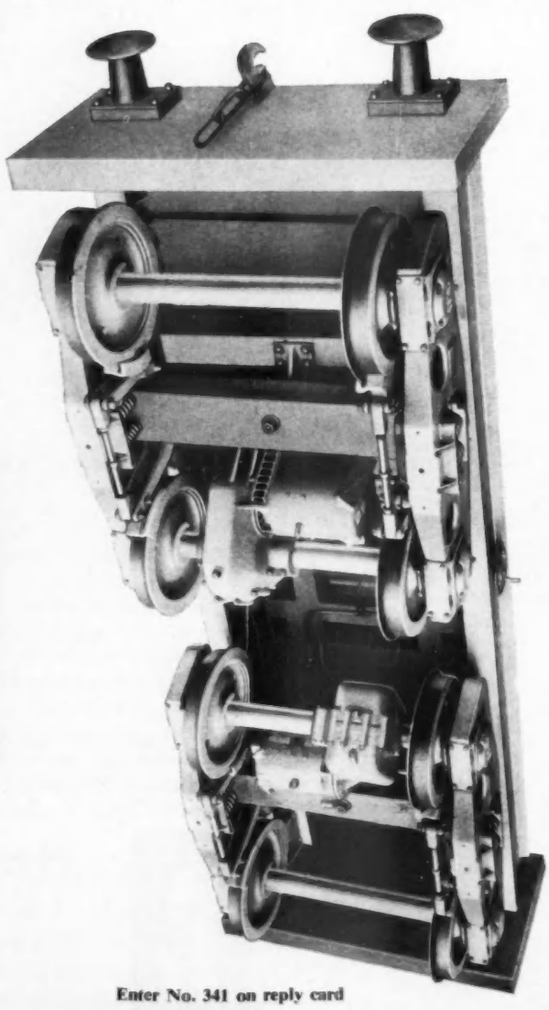
The frame is mounted on heavy-duty sprung twin bogies each having four single flange steel rail wheels and one driven axle. Robust coil springs absorb all shock loads produced by travelling over uneven track.



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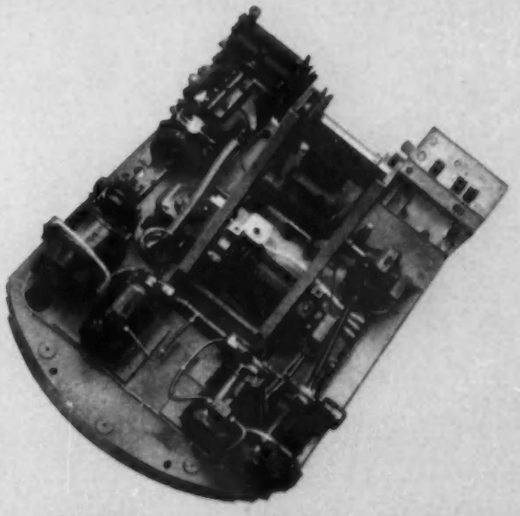
The operators cab, designed for maximum functional efficiency and comfort, provides an all-round view of the working area. Full weather protection is assured and fan or heater can be fitted to suit various climates.

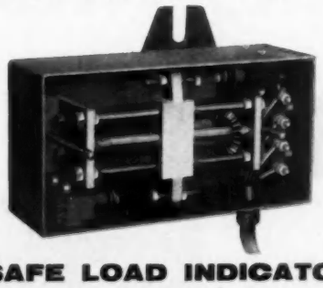


CLEAN SIMPLE LAYOUT

This clean, simple layout means ready accessibility and easy maintenance. A separate electric motor for each crane motion is powered by a variable voltage generator which is, in turn, driven by a diesel engine.

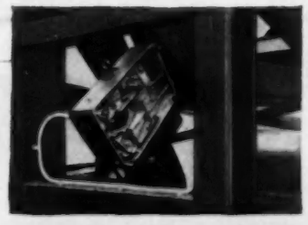
LIMIT SWITCHES

Self-resetting limit switches automatically operate should attempts be made to hoist or derrick beyond permitted limits.



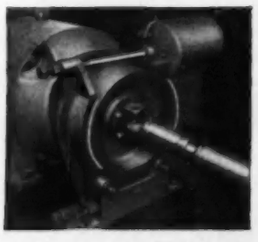
SAFE LOAD INDICATOR

Coles safe load indicator automatically prevents lifting of an unsafe load irrespective of the jib position.



ELECTRO MECHANICAL BRAKES

Electro-mechanical brakes, fitted to all crane motions, are immediately and automatically applied should the supply of current be interrupted for any reason.



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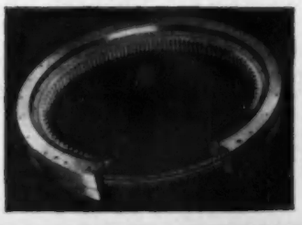
The superstructure revolves on a large diameter double live ring of steel balls running in hardened races, thus obviating the need for a centre post.



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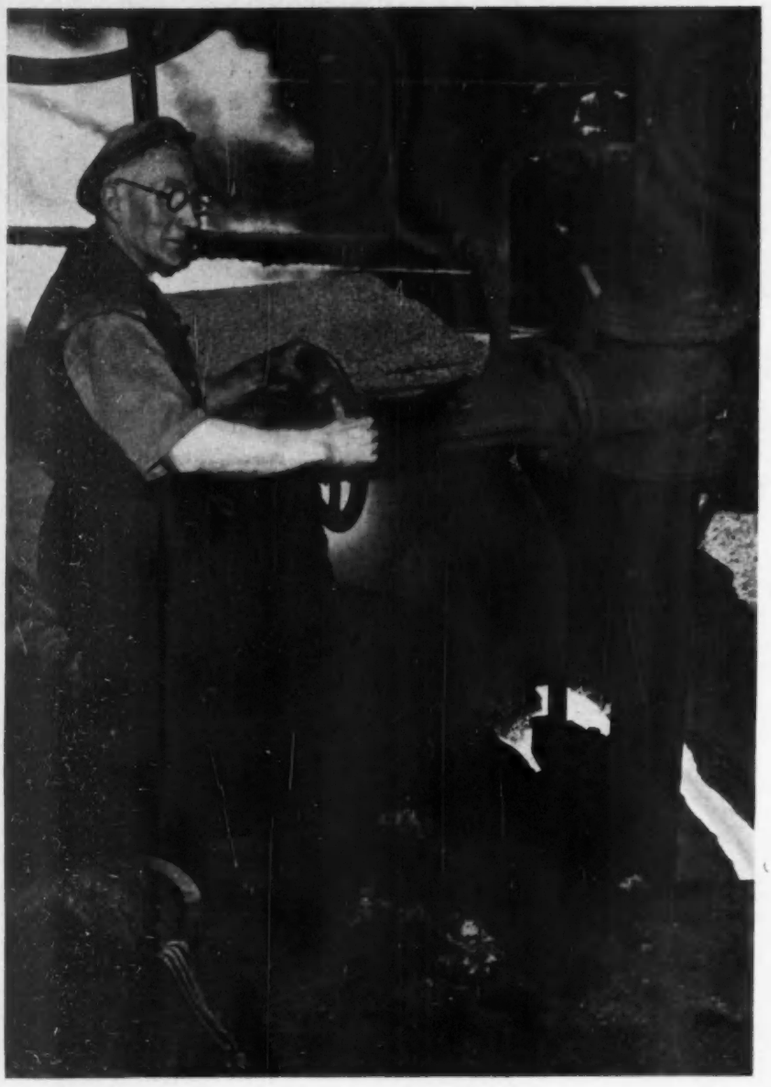
RANGER



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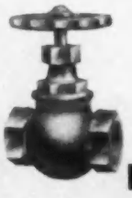

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Stoppages of plant can be a very costly business, affecting operators, works engineers and production managers. If the plant is properly protected by good, reliable switchgear, however, stoppages rarely occur. Ellison Fuse-switchgear, for example, can make life much easier for all concerned. Designed and built to B.S. 3185 : 1959, it will operate for long periods with little or no maintenance. No switchgear should be neglected but, rest assured, you can take it much easier with Ellison Fuse switchgear.

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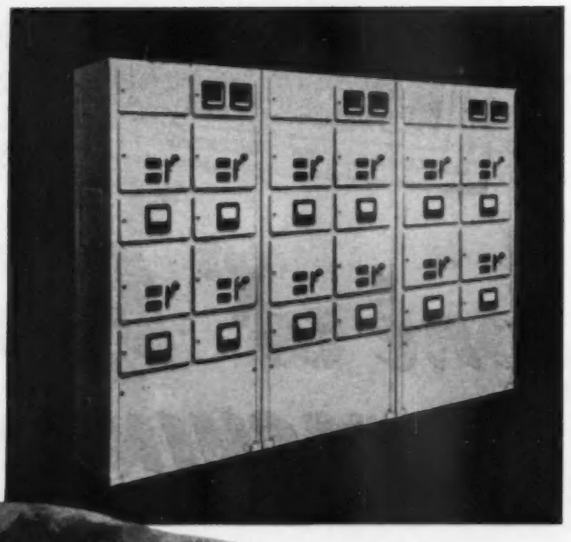

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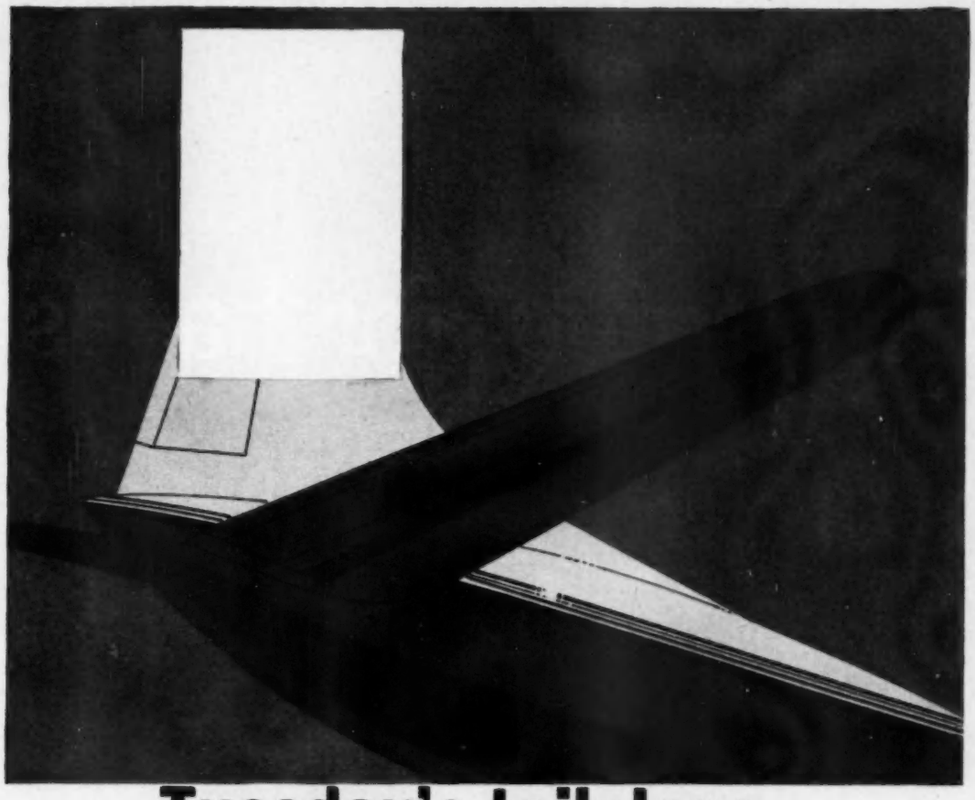
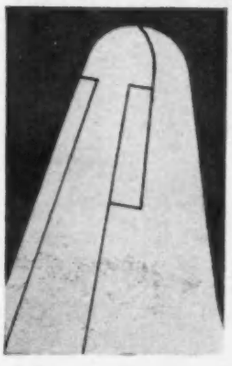


Tuesday's tailplane



There is no doubt that the tailplane will be there on Tuesday–or that every other part and sub-assembly will be available on the scheduled date.
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It is suitable for every type of organisation – large or small – whether manufacturing turbo-jets or children's bicycles.
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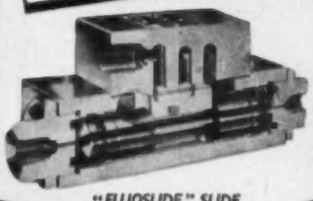

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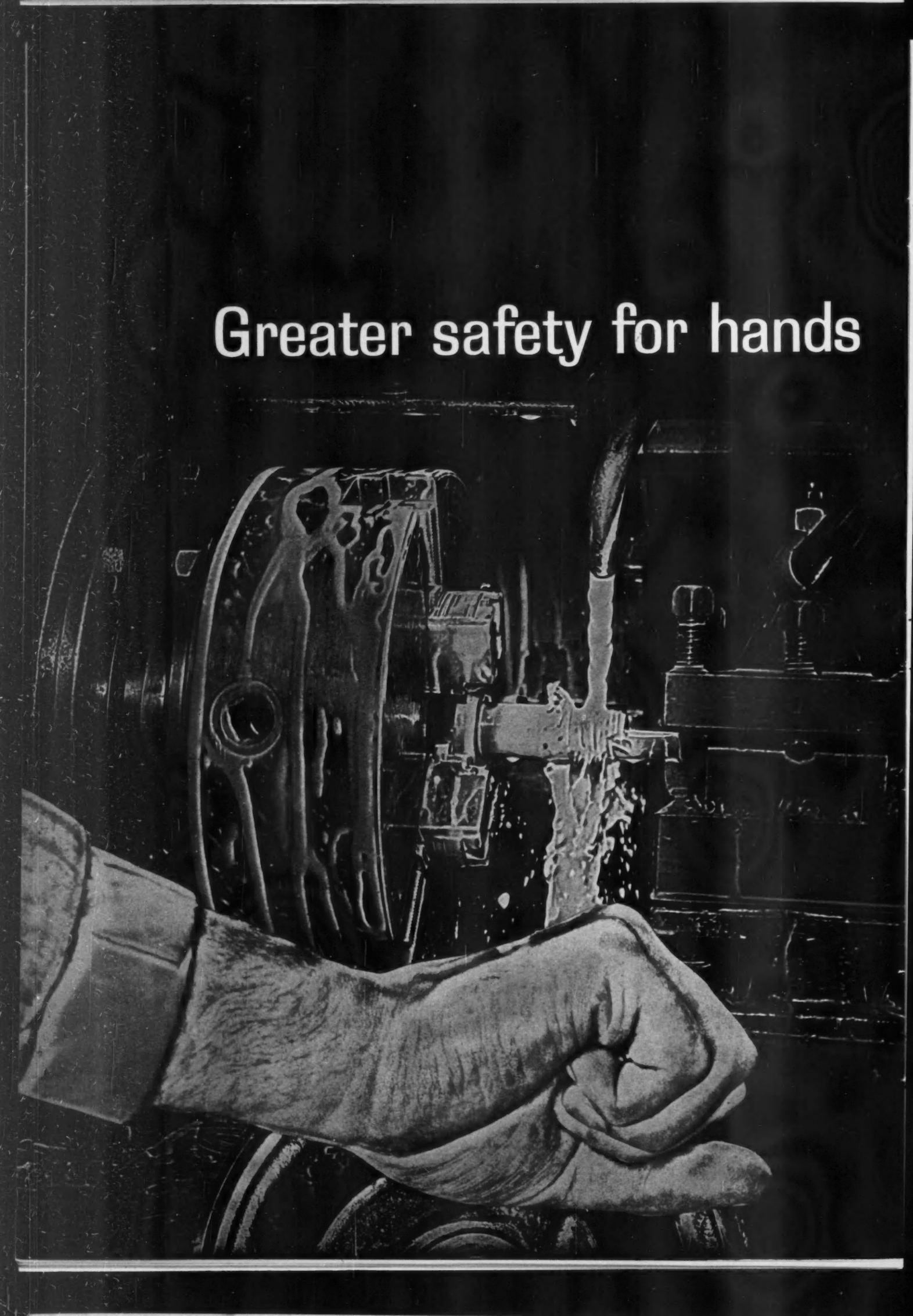


With new Shell Dromus Oils

Most modern soluble cutting oils contain phenolic compounds used as coupling agents between the oil and the emulsifier, for better blending and easier mixing. These phenolic compounds can cause skin irritation, especially where modern high-speed machines are used and the emulsion can concentrate, through the evaporation of water, above the safety level.

Shell research chemists have been working on this problem, which has been causing some concern to Management. After considerable research, Shell Dromus Oils have been reformulated and these new cutting oils now produce bland emulsions, which considerably reduce the risk of skin trouble to operators.

The real difficulty was to find a new coupling agent to replace the phenolic compounds, and Shell finally used what their chemists know as a higher fatty alcohol complex. This solved one problem, but presented another. The new coupling agent was volatile at the high temperatures normally used in blending processes. Further research found a solution to this problem by designing and installing new plant. The new Dromus Oils are every bit as efficient as before and cost no more. They put Management in the welcome position of being able to minimise working hazards at no extra cost. And machine men need no longer be so worried about skin troubles.

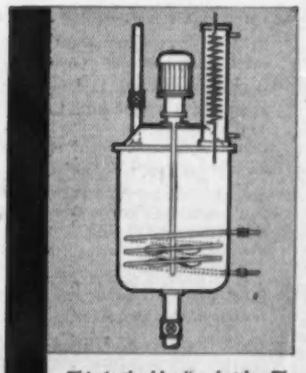
The moral of the story is that Shell research is supremely applicational. The centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organisation have any major lubricating problems, it pays to get in touch with your local supplier of Shell Industrial Lubricants.

The Research Story

Shell chemists in the U.K., in Holland and in the U.S.A., prepared and examined hundreds of experimental soluble oils, and established that certain combinations of fatty alcohols could be used in place of phenolic compounds with no loss of efficiency. They set to work to discover the best combination and developed a higher fatty alcohol complex which fitted exactly. Then they realised that to blend this new coupling agent into soluble oils would require special plant and new blending techniques.

Exhaustive testing of blend stability, emulsion stability, anti-corrosion and machining properties led to selection of the most promising blends. A pilot plant was set up to produce batches of these for use in field trials.

This field testing and final development proceeded for two years whilst production plants were erected at points so chosen as to give the most economical and rapid delivery throughout the United Kingdom.



This is the blending kettle. The reflux condenser beside the stirrer motor prevents the loss of constituents volatile at the blending temperature.

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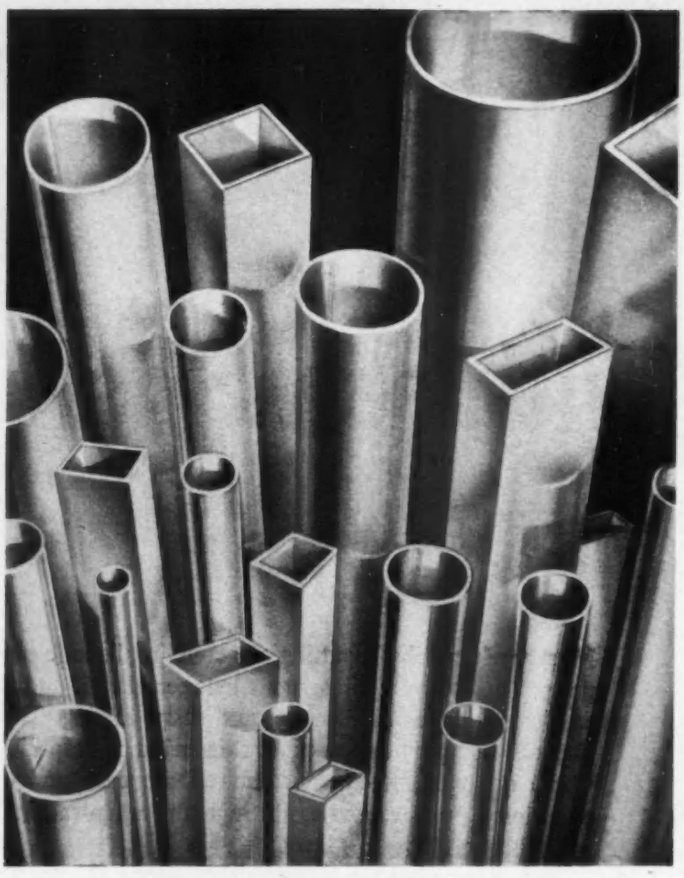

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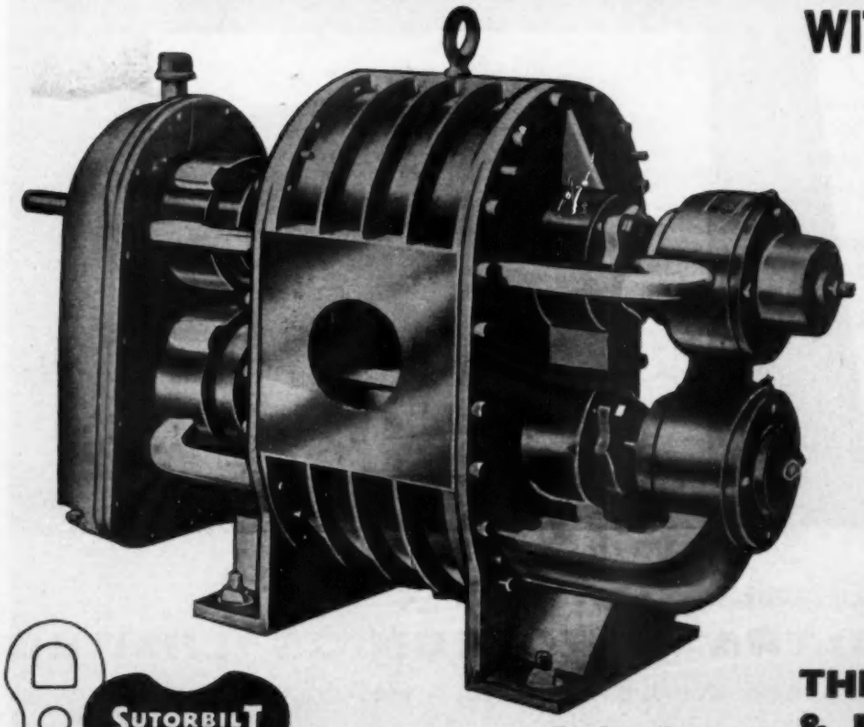

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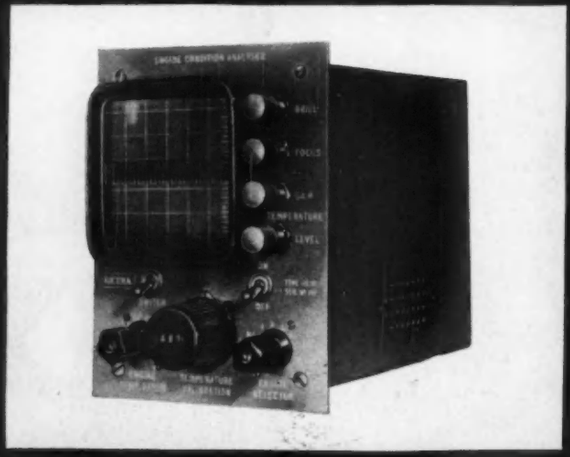

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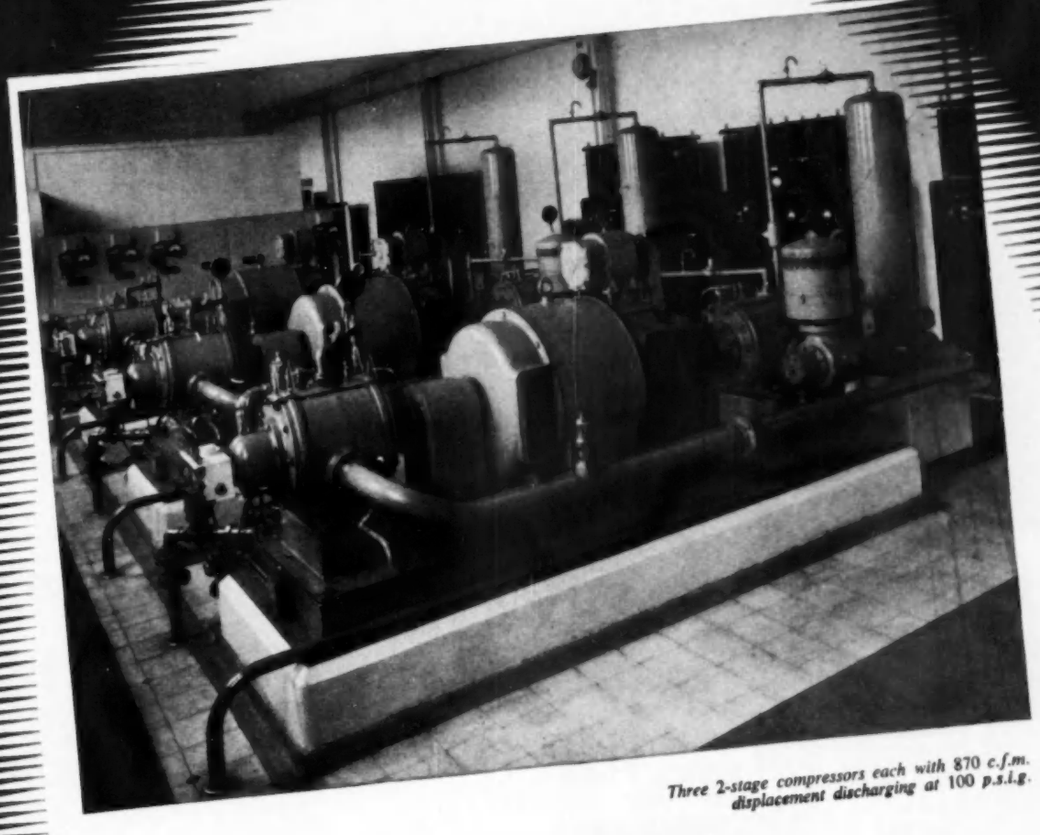

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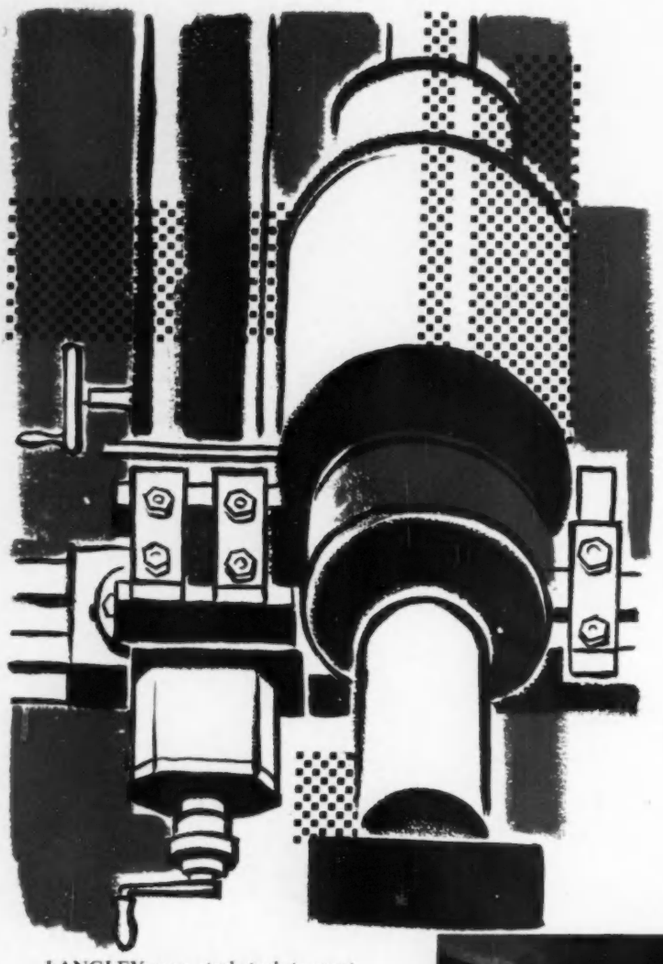

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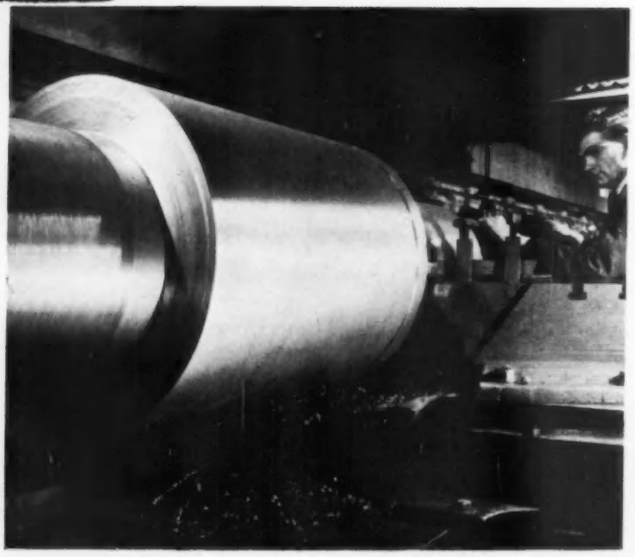

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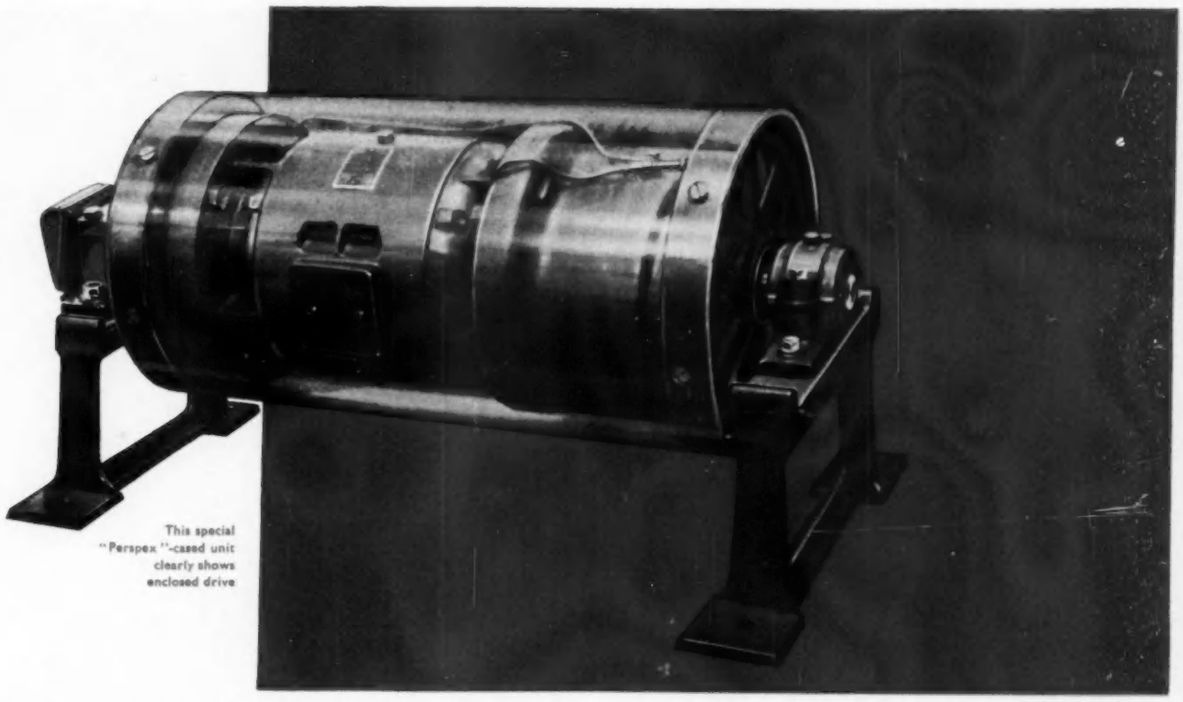

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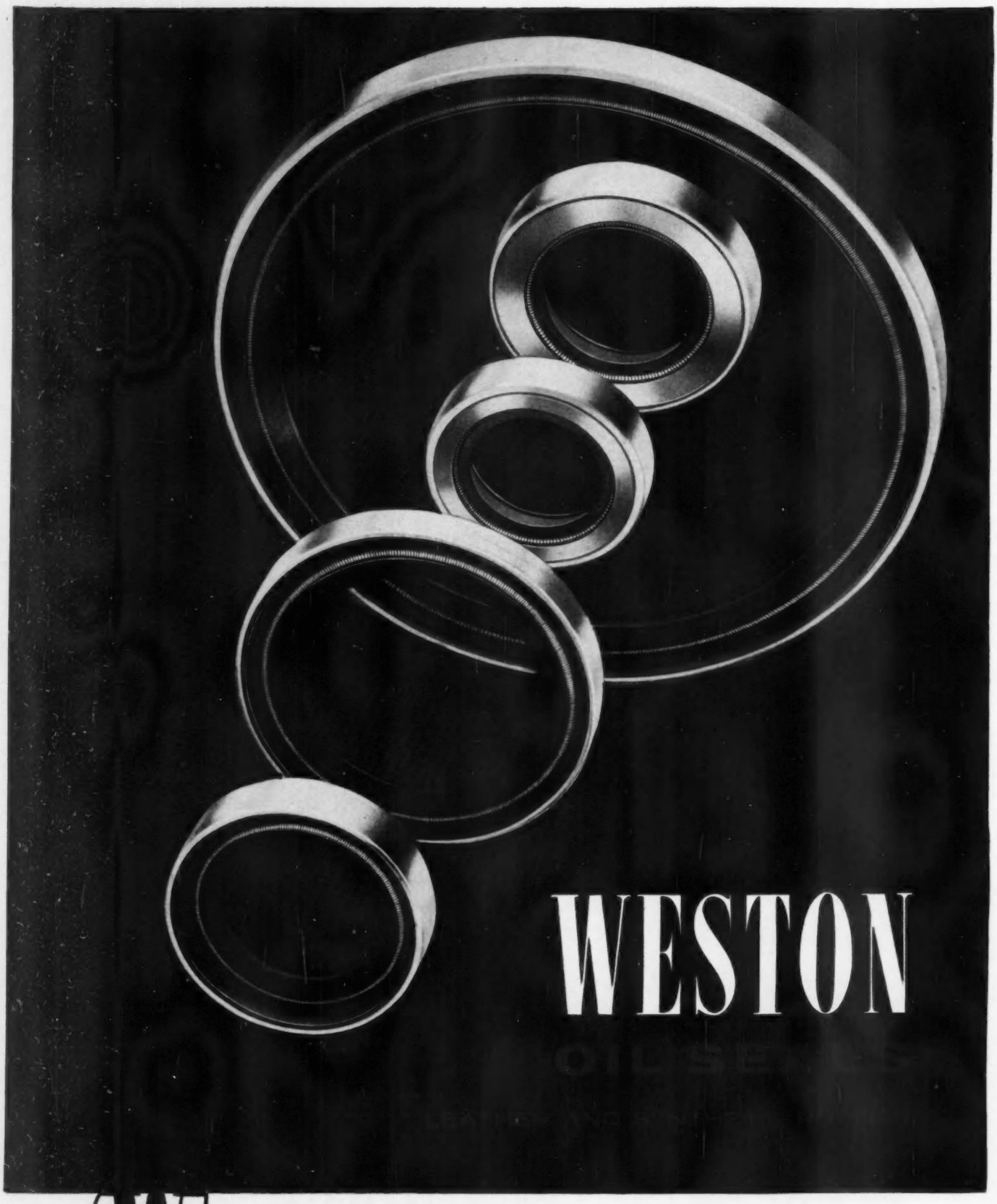

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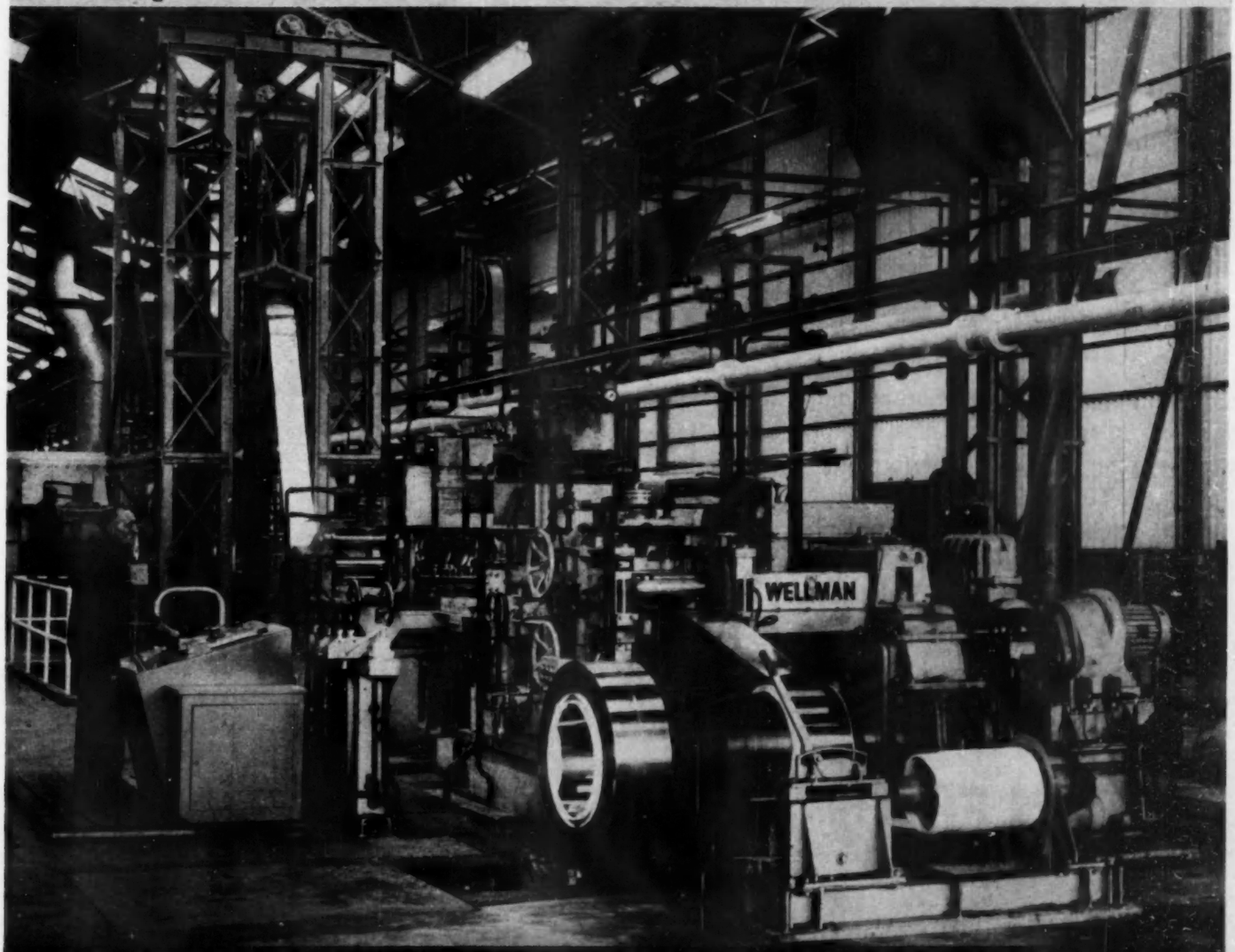

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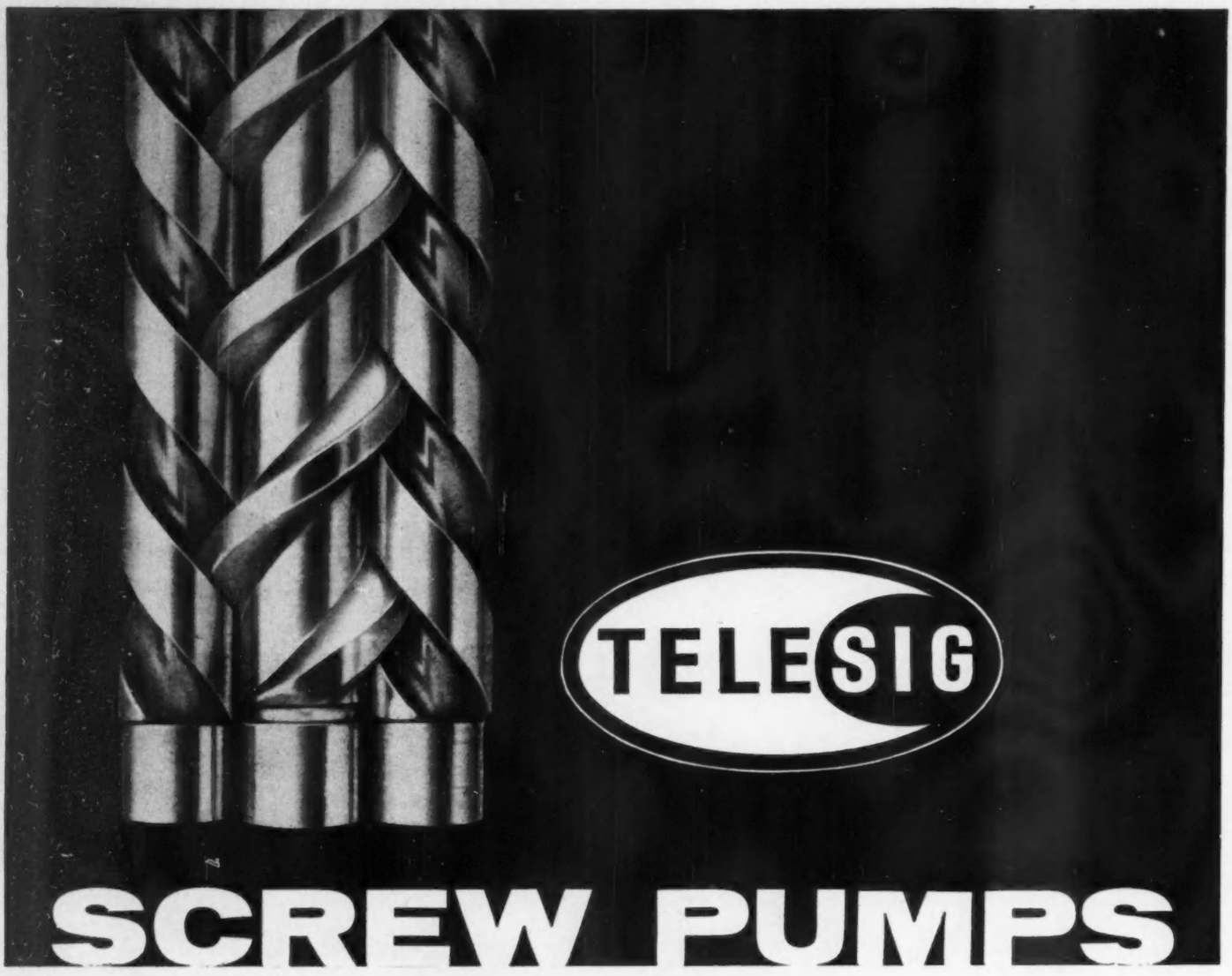

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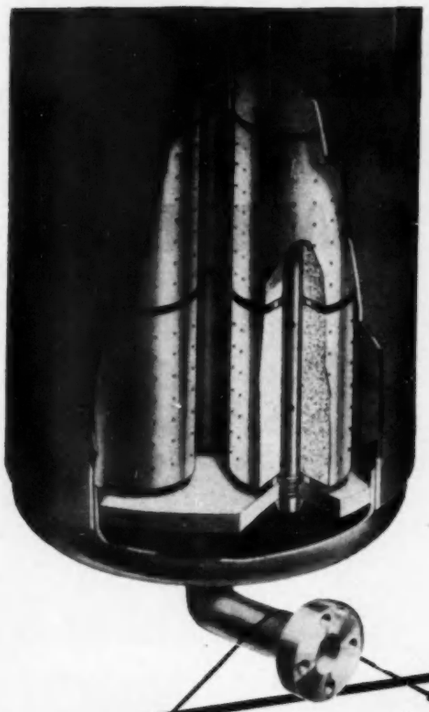

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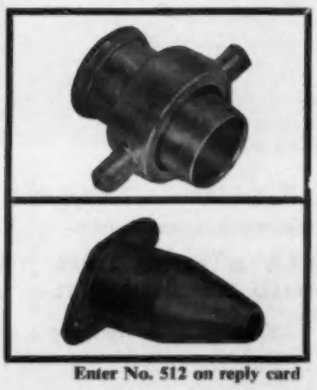

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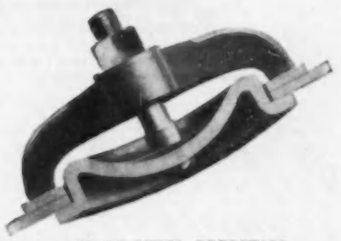

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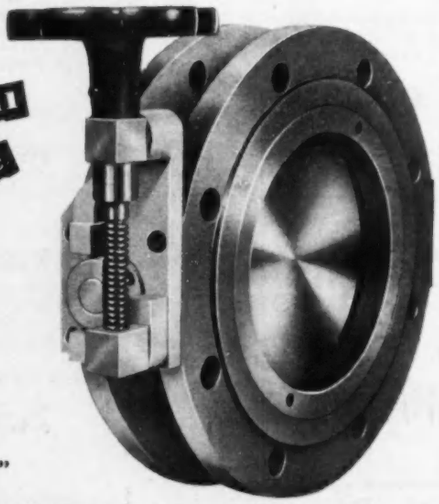

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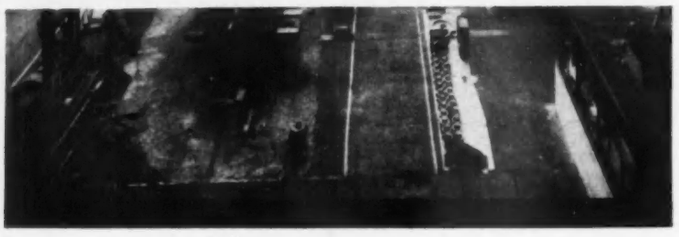

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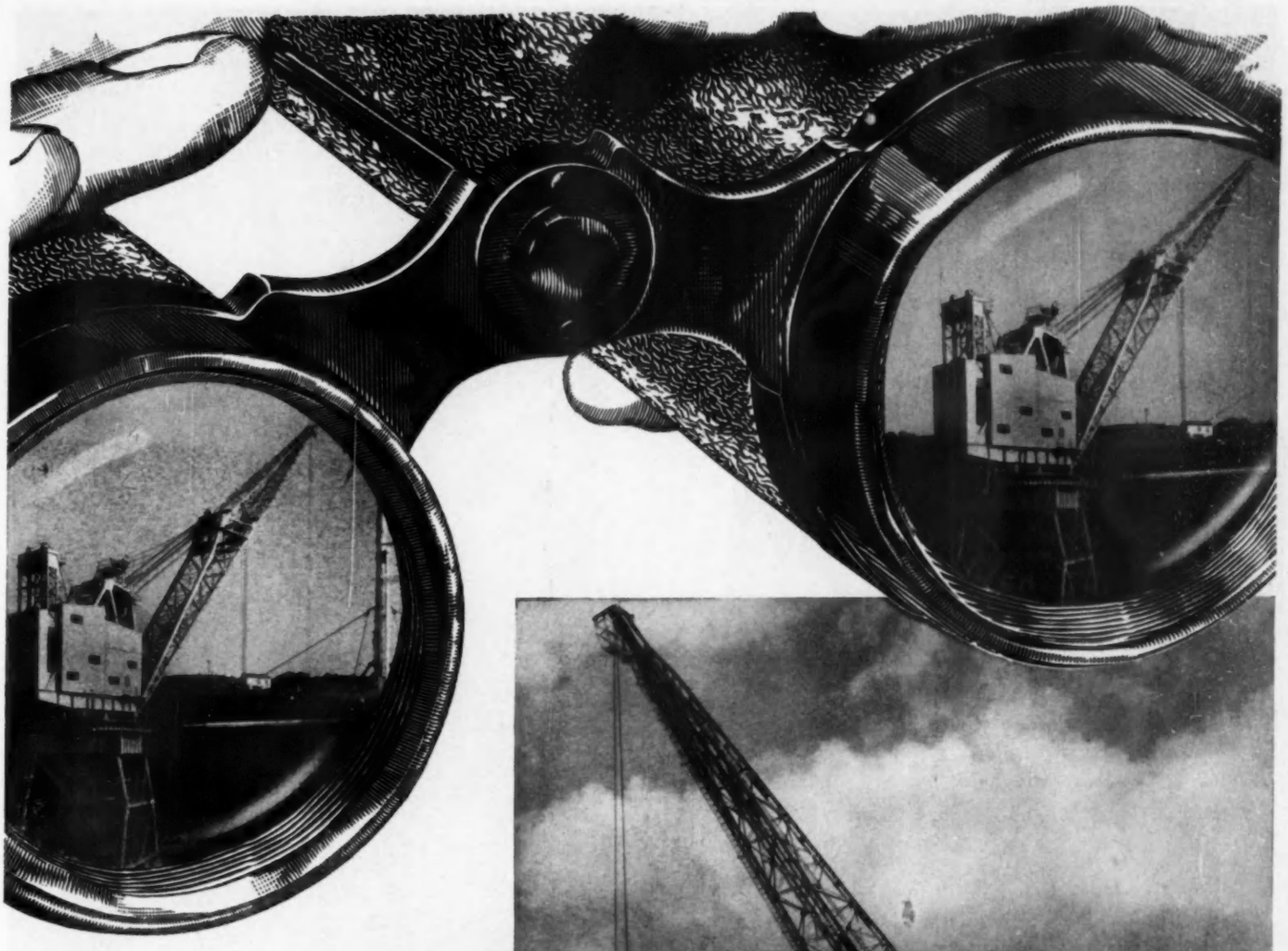

Focus on Falmouth

A new Falmouth landmark visible from far at sea is this 247 ft. high Stothert & Pitt crane built for Messrs. Silley, Cox & Co. Ltd. It is one of the largest balanced rope level-luffing cranes in the country and can lift up to 61 tons at 105 feet radius. Ward Leonard hoist drive ensures precise control on both main and auxiliary hooks.

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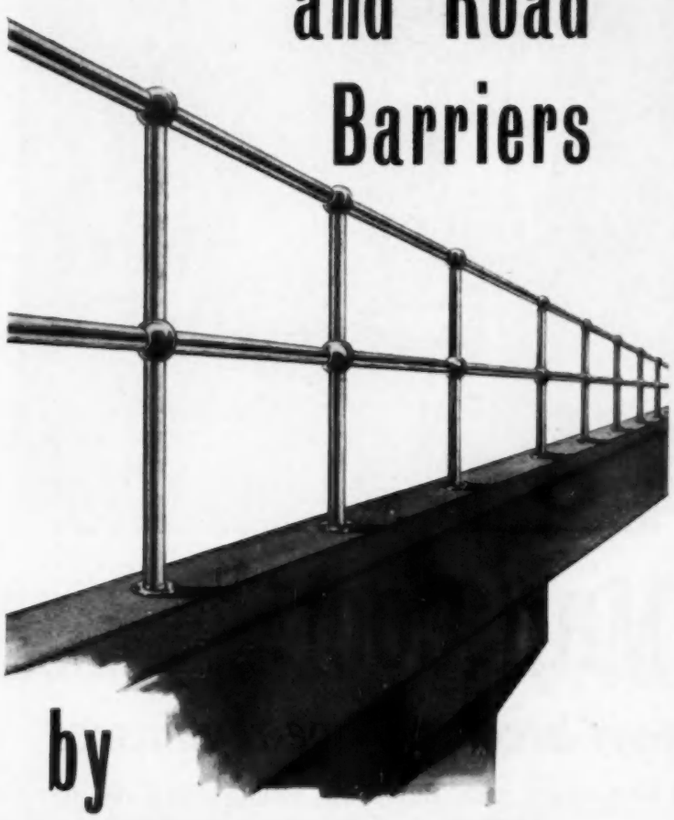

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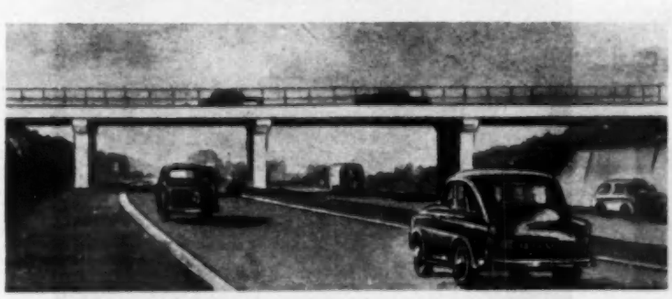

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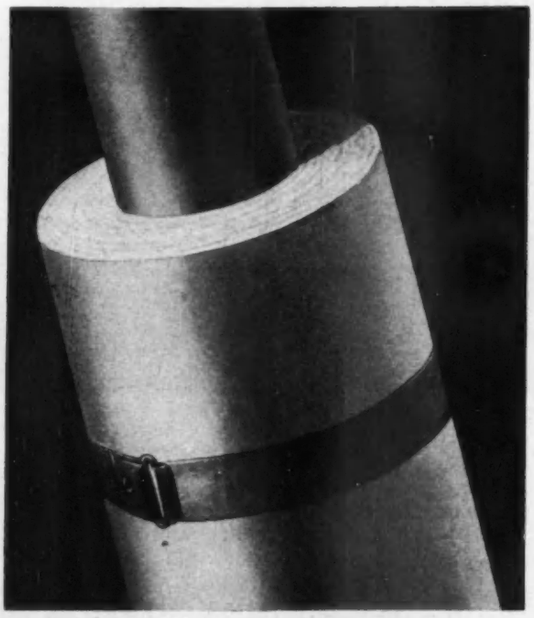

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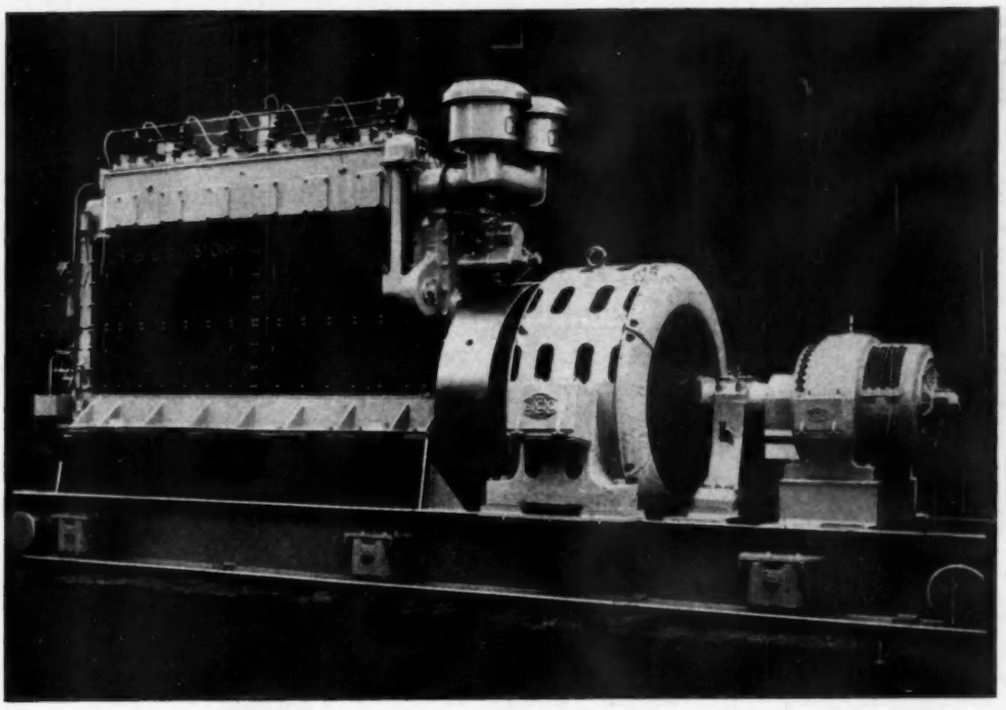

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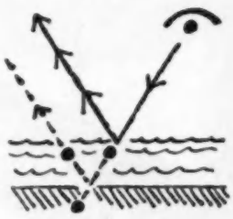
Electrical Aids in Industry *Data Sheet* **No.13**

Infra-Red Heating

Infra-red heating is the name given to the method of using in industrial processes radiant heat from heaters specifically designed for that purpose. This differentiates it from methods employing both radiation and convection, as in furnaces, although the effect of the radiation is much the same in both cases.

Radiant heat provides a higher rate of heat transfer to bodies not highly reflective than does convection, unless high-velocity forced convection is used. The rate of heating of a body depends on the intensity of radiation on its surface, the proportion absorbed by the surface and, after that, on heat conduction. In heating very thin bodies, for example paint films, the radiation not reflected nor absorbed passes through and is in turn reflected or absorbed by the underlying material. This reflected heat is partly absorbed by the paint film "on the way back". Despite this effect it is an exaggeration to claim that infra-red "heats from the inside out" and it remains largely a surface heating effect except in a few special cases.



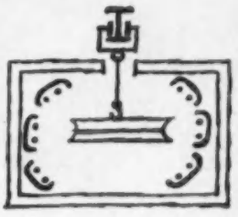
Infra-red heaters mainly use metal-sheathed elements in special reflectors, but infra-red lamps with internal reflectors are still used in special cases. Other types use silica-sheathed elements or quartz-sheathed lamps in reflectors. A wide range of heaters is available with simple mounting arrangements to enable heat to be applied quickly and effectively either in a production line or in some odd corner.

Control of the charge temperature is effected by regulating the heating time and power. In the case of a moving charge, this is done by adjusting the conveyor speed and the number of heaters in circuit, i.e., by adjusting the effective length of the oven. Some of the heaters may be controlled by energy regulators or adjustable transformers.

The advantages of infra-red heating over convection heating include reduced heating times, reduced floor space, lower installation costs, almost instant starting, ability to focus the heat, and flexibility in effective oven length. Infra-red ovens can often be mounted in the roof, saving valuable floor space. Infra-red heating is not generally favourable for heating large bodies of low heat conductivity.

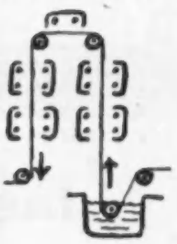
Paint Stoving

Not all paints are suited to infra-red radiation, but suitable paints are stoved quickly and often give a better finish. Synthetic enamels are the most suitable. Articles that can be successfully stoved include motor car bodies, wheels and other accessories, refrigerator and washing machine cabinets, cylindrical drums and barrels, metal furniture, valve hand wheels, metal toys and a host of other articles. Lacquers and varnishes are being quickly and effectively stoved on jewellery, packing strips, tubes, films and similar products. Special infra-red lamp ovens stove synthetic finishes on wooden furniture and components. In all cases stoving times have been reduced very considerably.



Moisture Extraction

Sheathed element heaters are particularly useful for drying surface water films, their radiation being readily absorbed by water. High rates of drying are possible provided the water vapour can readily disperse. Drying of "contained" water can be effected provided the water can diffuse from the interior at a rate equalling the surface drying rate. With heat-sensitive materials sheathed element heaters may have to be arranged to move away from the material to avoid overheating if the conveyor stops, being interlocked with the conveyor for this purpose. Lamps are sometimes used instead for such materials because of their instantaneous cut-off.



Infra-red is widely used for drying coatings and inks on paper and textile products, bottle seals and labels, clayware and glazes, pigments on leather and many other products.

Plastic Heating

Infra-red heating is widely used in the plastics and allied industries. Typical applications are the pre-heating of plastic pellets and of sheets prior to moulding, curing of plastic and rubber sheets and belts, heat setting of nylon and similar fabrics, drying and curing of latex films on carpets and many others where a plastic forms the whole or part of the product.

The above are just a few examples of successful applications of infra-red. In many other processes infra-red heaters can often be fitted quickly and cheaply, to save time, labour and floor space and, therefore, money.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/– post free) are available — "Resistance Heating" is an example; "Induction and Dielectric Heating" is another.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

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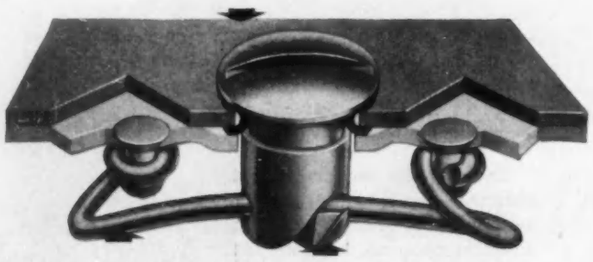

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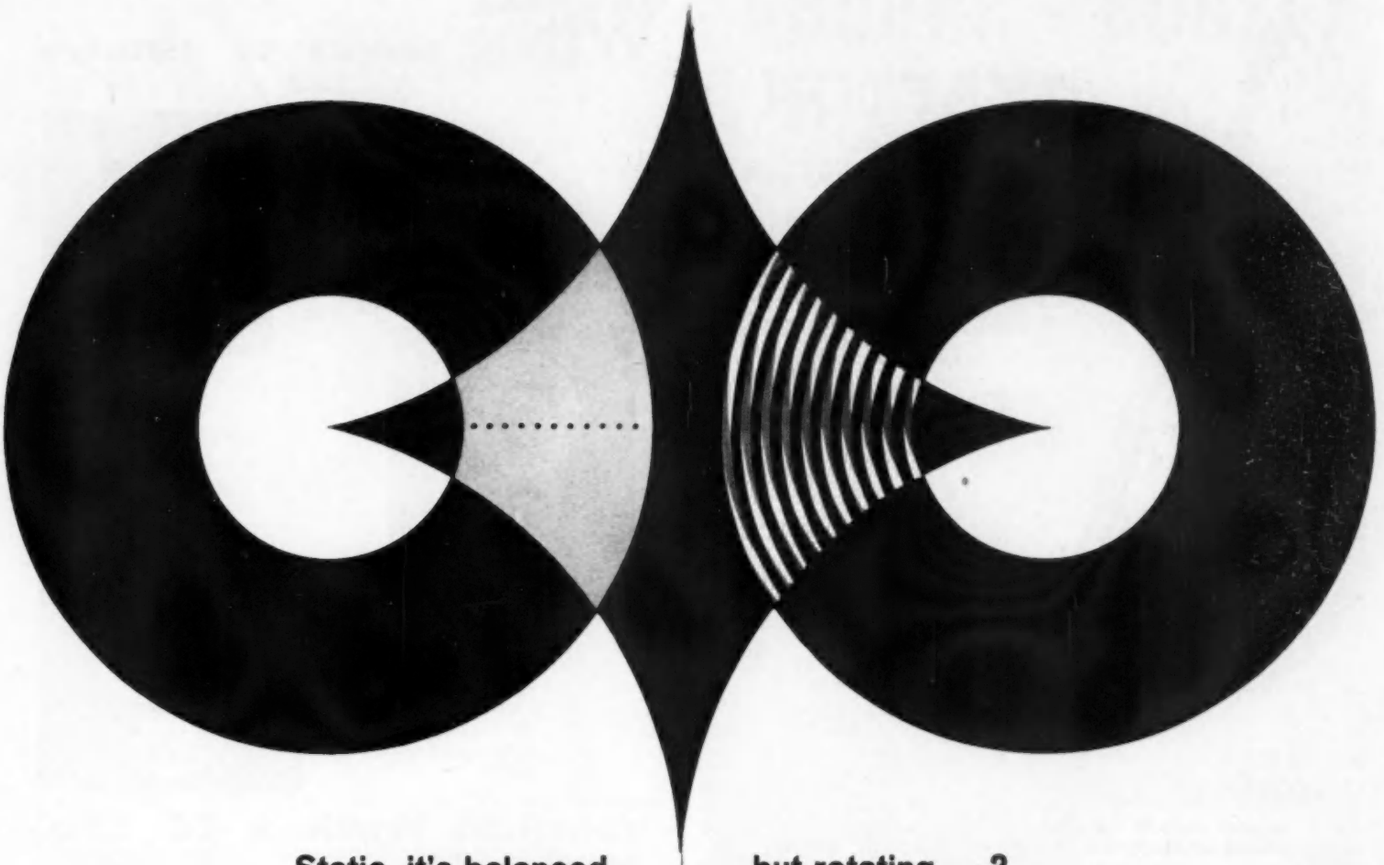
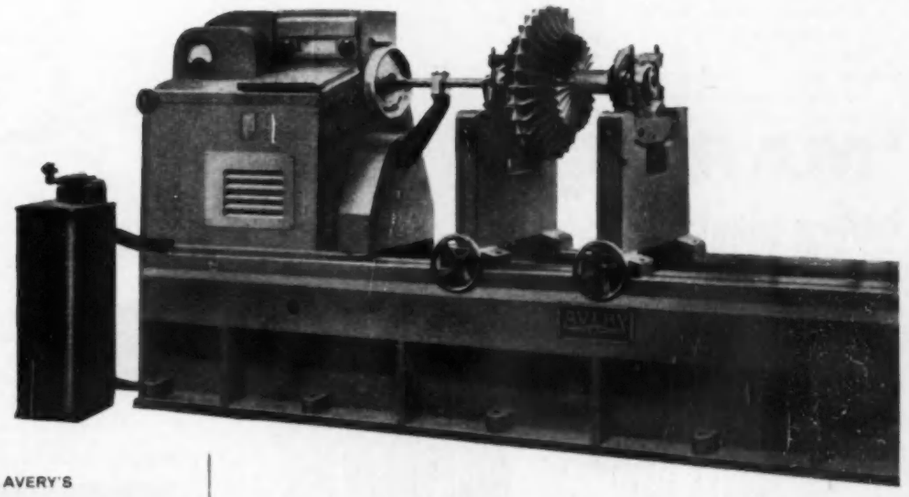


Static, it's balanced but rotating . . .?



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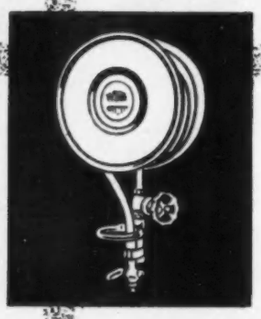

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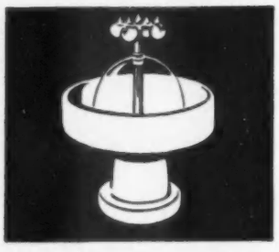

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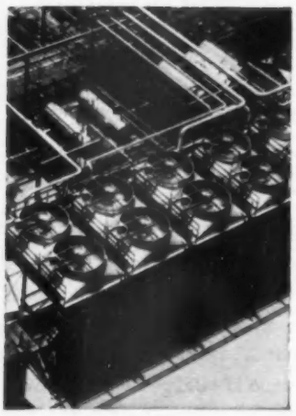

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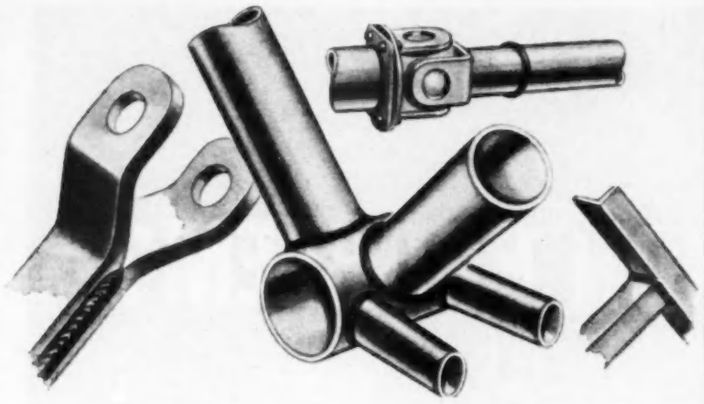

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- *In profitable product recovery*
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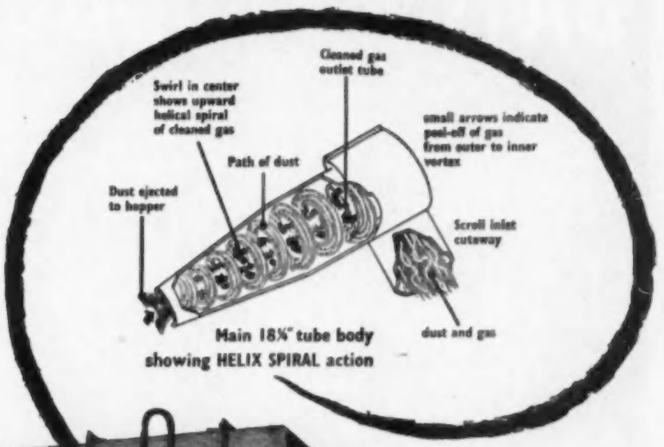
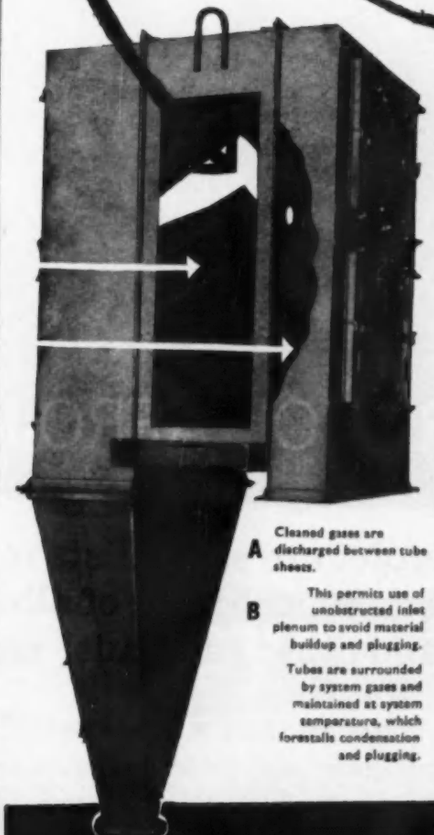

Cleaned gas outlet tube
Swirl in center shows upward helical spiral of cleaned gas
small arrows indicate peel-off of gas from outer to inner vortex
Path of dust
Dust ejected to hopper
Scroll inlet cutaway
dust and gas

Main 18¾" tube body showing HELIX SPIRAL action



A Cleaned gases are discharged between tube sheets.

B This permits use of unobstructed inlet plenum to avoid material buildup and plugging.

Tubes are surrounded by system gases and maintained at system temperature, which forestalls condensation and plugging.

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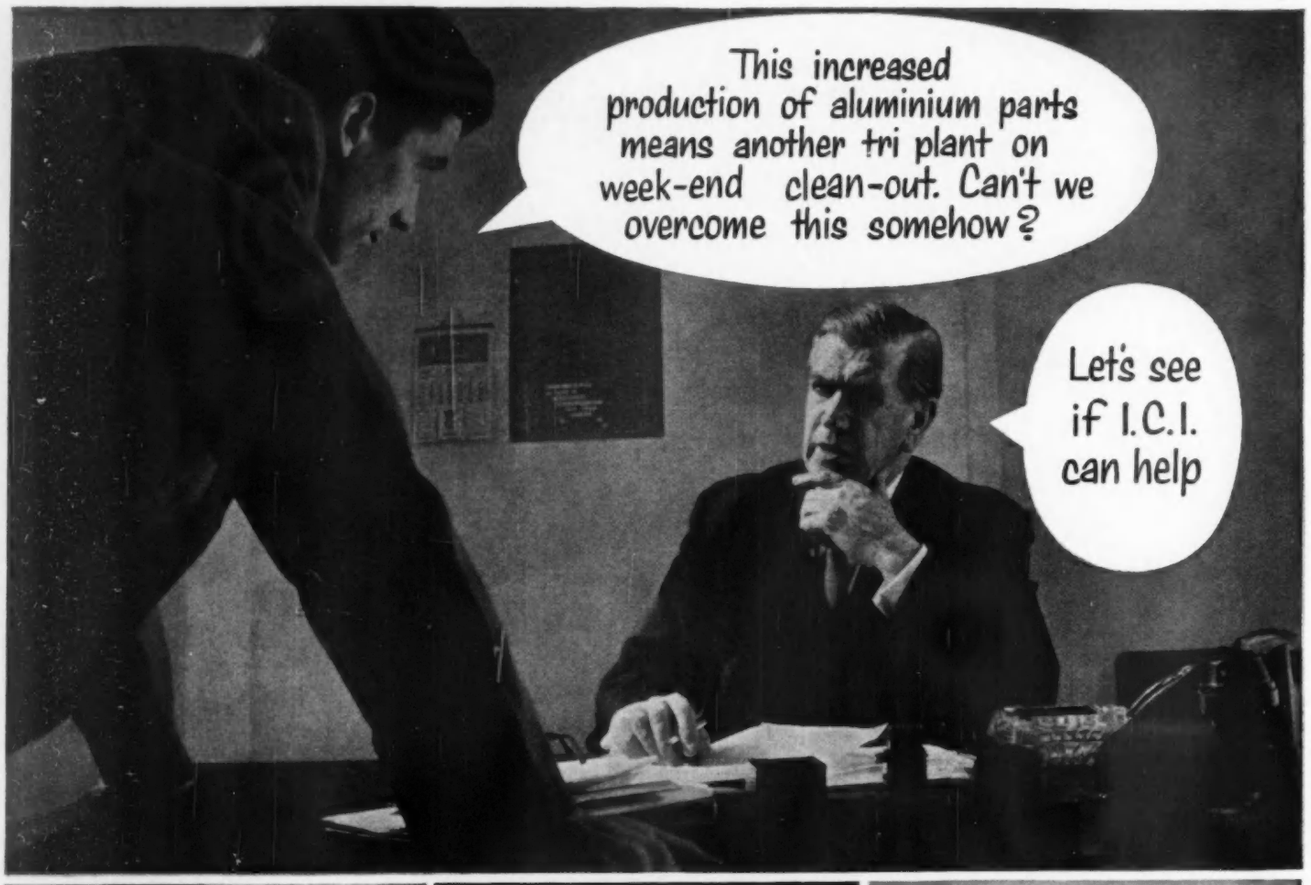
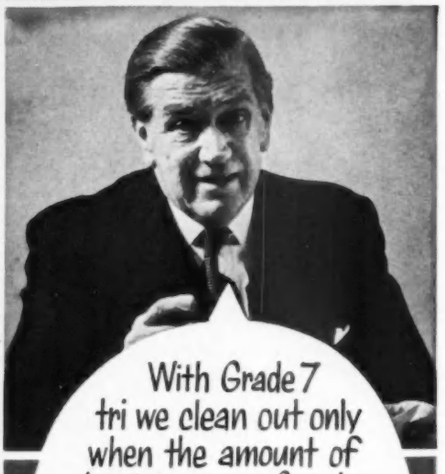

This increased production of aluminium parts means another tri plant on week-end clean-out. Can't we overcome this somehow?
Let's see if I.C.I. can help



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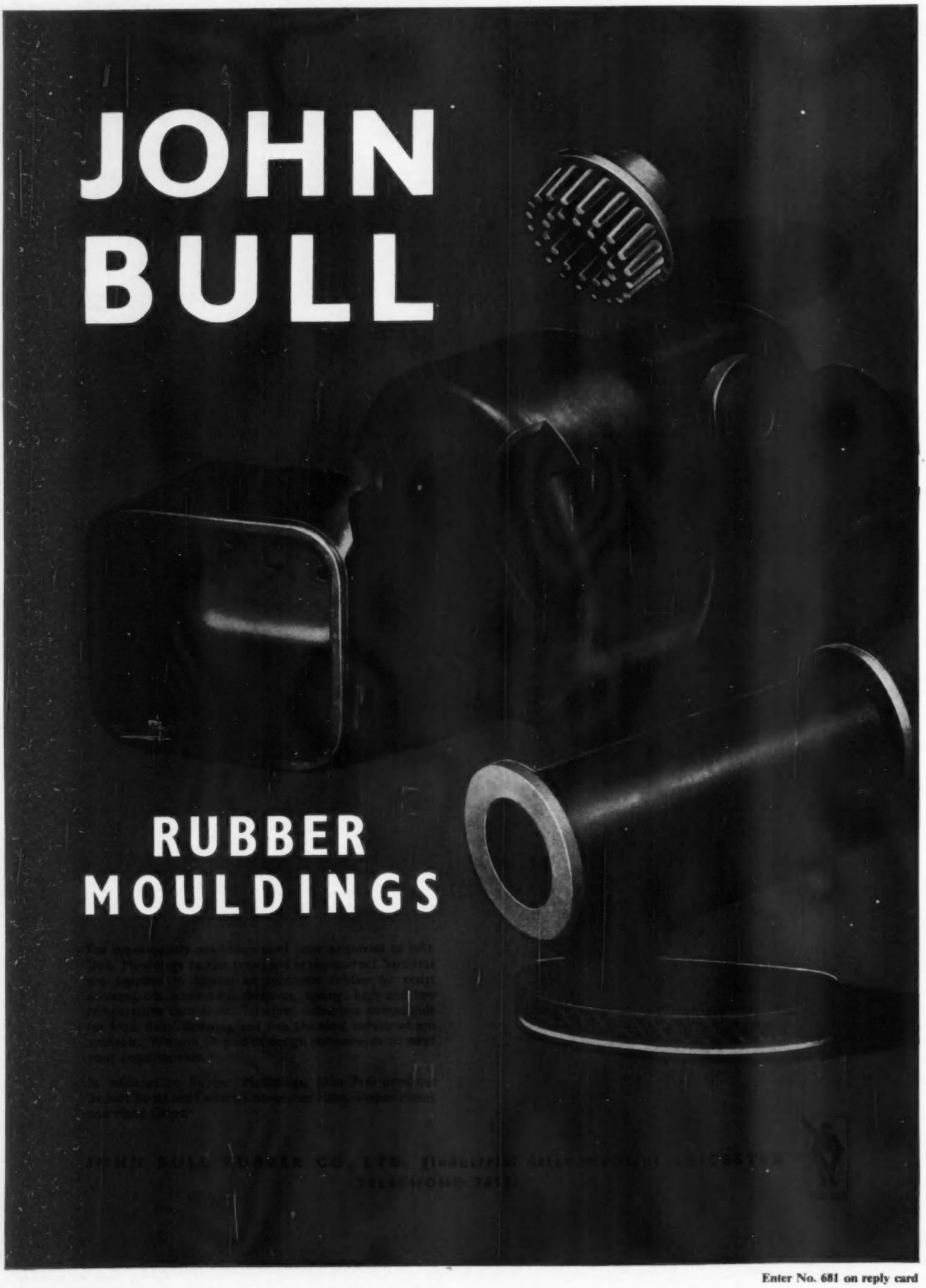

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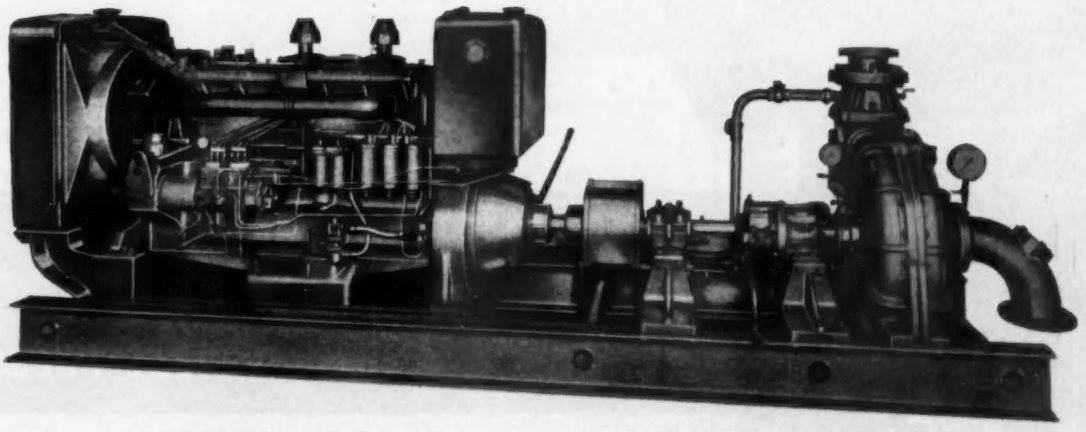

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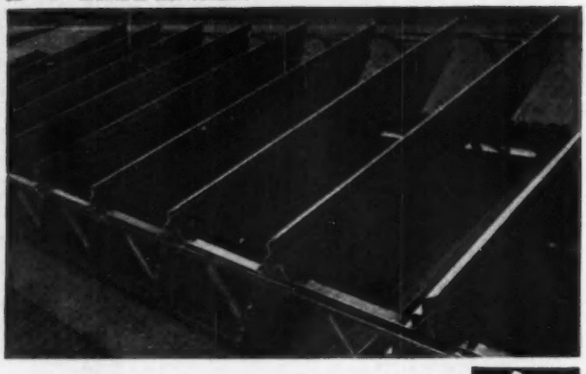

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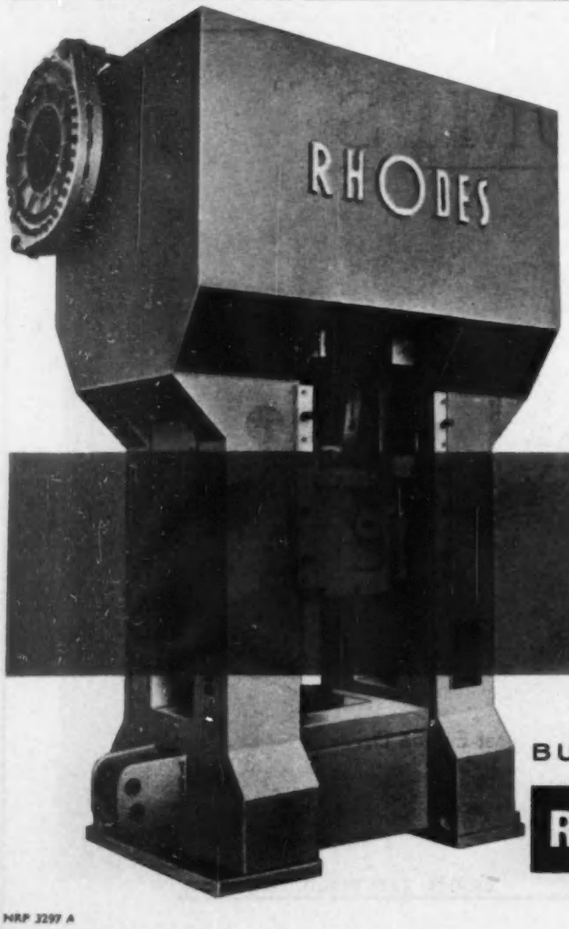

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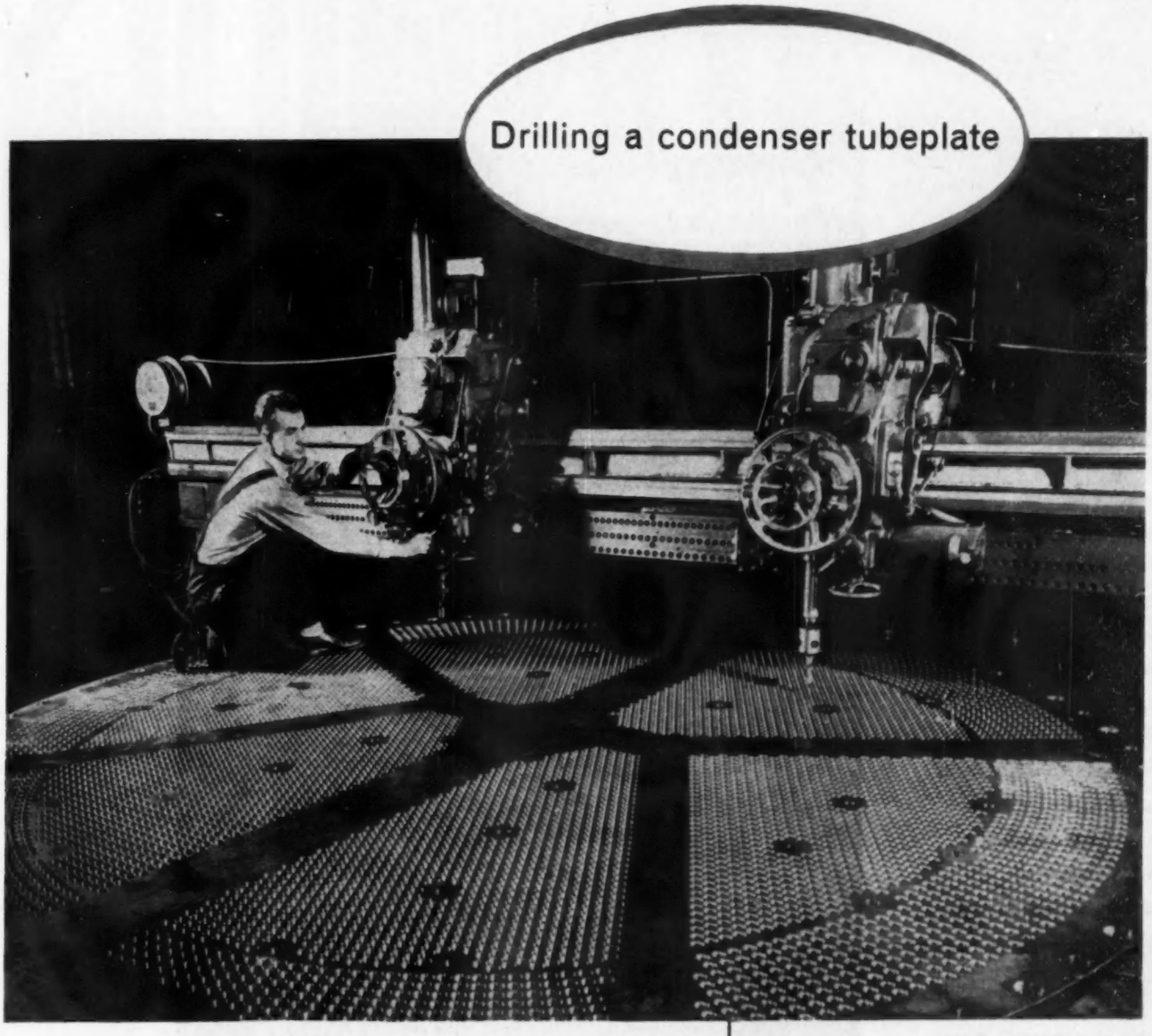

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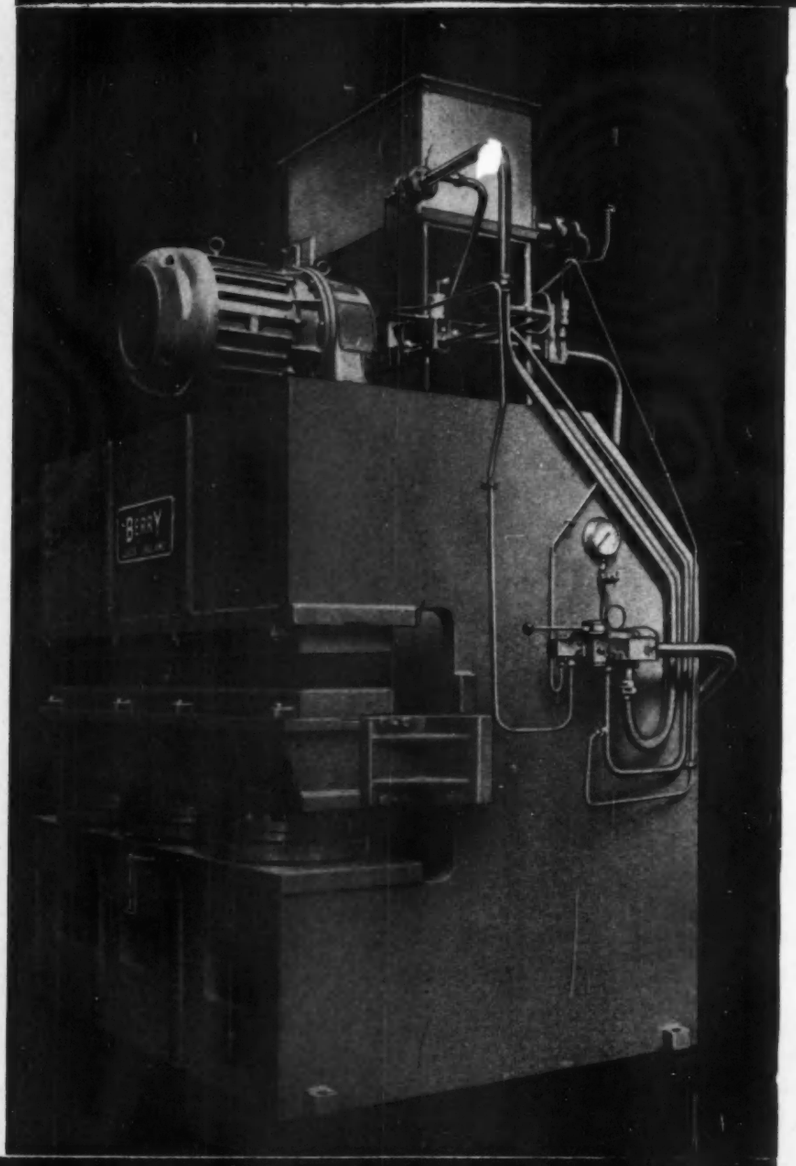

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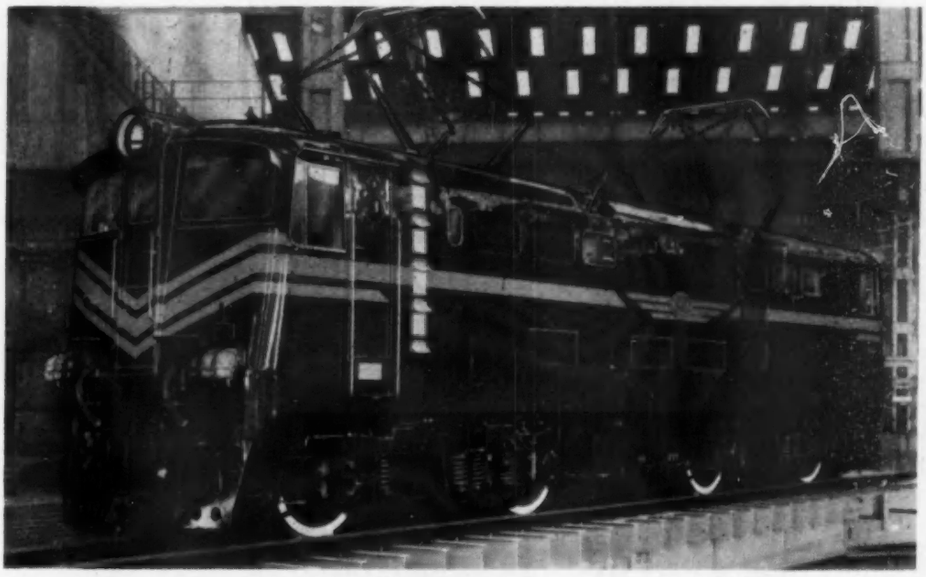

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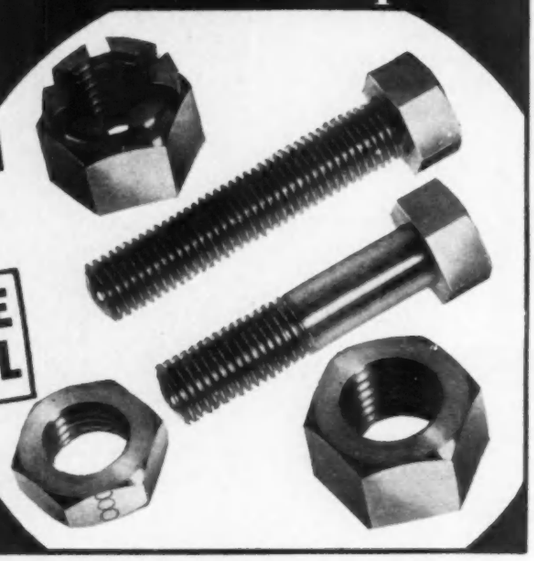

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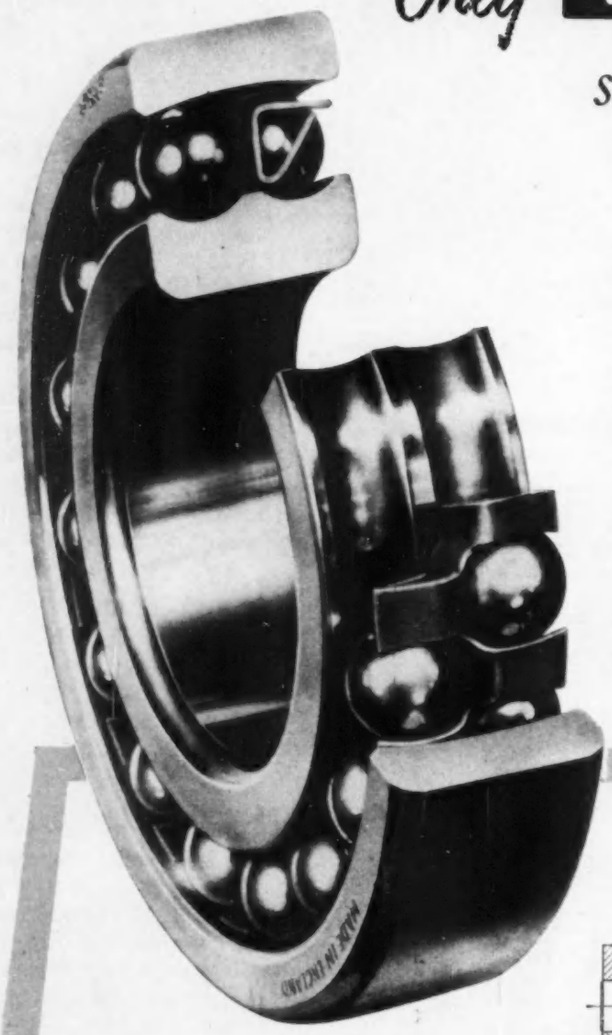

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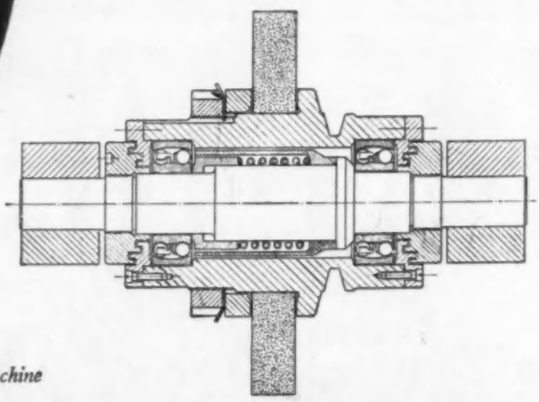

Bearing scheme for grinding wheel of leather shaving machine

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THE ENGINEER

No. 5464 OCTOBER 14, 1960 Vol. 210

SHIPBUILDING CRITICISED

Although stated to be confidential, some account of a report on the Shipbuilding industry prepared by the economics staff of the Department of Scientific and Industrial Research has appeared in the press together with guarded comment from leaders of the industry. Although we have not had sight of this report it would appear that its general tenor has a family likeness to the statements made in the Annual Report of the Advisory Council on Scientific Policy in 1957 and to remarks made by Lord Hailsham at this year's annual dinner of The Royal Institution of Naval Architects. Stormy exception, according to statements quoted in the press, has been taken by industry to the current report and no doubt a strong reply will be forthcoming when the report has been studied and its strictures assimilated. Remembering that, after a forthright rebuttal by Sir J. A. Milne, the Advisory Council's criticism was not repeated in 1958 it gives rise to the question of whether those who prepare such reports, attempt to translate a paper study, assisted only by a superficial knowledge of the industry and without making due allowance in the formula for the human element.

Naturally the industry cannot turn a Nelsonian eye upon such a report for no doubt there is room for considerable improvement in some ways. In labour relations, for example, there is an over-riding need to eliminate demarcation disputes and unofficial strikes. It will be remembered that the productivity team which visited Sweden last year confirmed that in that country there is in practice only one trade union for negotiating purposes and that there is great flexibility in the steel trades. These conditions, coupled with a wide degree of consultation, clearly make for better labour relations and go a long way towards removing the causes of demarcation disputes. They just as clearly emphasise the need for less independence and more interdependence in union matters. Furthermore wildcat strikes are illegal and there is provision for claiming compensation from either union or employer for losses incurred by an industrial stoppage. Clearly provisions like these must give both sides of industry cause for pausing to have second thoughts and so contribute to industrial peace and increased production. There is, of course, scope for improvement in the quality of management — there is in all industries — and perhaps there could be more courses in shipbuilding production and methods such as were held a year or so ago. Until recently, the industry has been fully employed since the war. It has therefore had to maintain production while at the same time carrying through modernisation schemes so as to meet the competition of foreign yards, many of which had the opportunity for complete reconstruction immediately after the war. Having spent a sum approaching £120 million on modernisation programmes it cannot be said that the industry, as a whole, has been backward in providing equipment to permit the use of new shipbuilding techniques, although there may be certain yards which have not as yet invested in new machinery and adopted new methods.

Like many industries the shipbuilding industry would benefit from some degree of rationalisation, as it did after the first world war. The remark probably applies perhaps more particularly to the smaller firms where, when yards are in close proximity, amalgamation would improve efficiency and strengthen the financial structure. Standardisation of parts, and auxiliary fittings would also contribute its mite to industrial efficiency, as would the building of more sister ships for the same service. The latter has particular significance for oil tankers; but it also occurs for cargo ships when a number of a particular class are built. Nevertheless British shipowners, the main source of orders for British shipyards, operate in a highly competitive business often against subsidised competitors and require ships suitable for a wide variety of trades and trading conditions. The specifications for these ships are dictated by experience, highly successful experience when efficiency and not national considerations govern the carrying of cargoes. We rather suspect that the D.S.I.R. report whose contents have been prematurely revealed is a "draft" circulated amongst shipbuilders for comment and it was certainly never intended for publication in its present form. Such a confidential document would be likely to include criticisms to which it would be expected that replies would be made. We now learn that after the report has been discussed by the Research Council, the Shipbuilding Conference and the Ministry of Transport a "statement" on the outcome will be made. Would it not be better to publish an agreed version of a report which ought to assist in defining the research and development requirements of the industry? May we hope that the industry will not have been prejudiced against the report by premature revelations about its contents.

PROGRESS TOWARDS CLEAN AIR

For three days last week the National Society for Clean Air held a conference at Harrogate. After an opening session on the Wednesday the conference really got down to business that afternoon in a discussion of air pollution by road vehicles. Anyone who has done much driving on the roads of this country will be aware how many heavy goods vehicles pour out quantities of black and acrid smoke under certain conditions, especially, for example, when hill-climbing. The reasons for the production of such smoke were made plain enough at the conference. In the majority of cases there can be little doubt that faulty maintenance, deliberate abuse by drivers of controls, or deliberate tampering by drivers with governors and excess fuel devices is the cause. It might be supposed that the law could easily be invoked to prevent the emission of such smoke. In fact, however, under the existing state of the law the police find it practicable to prosecute with any hope of success in court only when there has been emission of very black smoke; and it is doubtful whether the public is ready yet to accept laws

similar to those ruling in the State of California in the U.S.A. which are really effective in preventing smoke emission.

On the Thursday the conference turned to the consideration of technical matters relating to research into a variety of facets of air pollution and to discussions of observations and research into the control of smoke from domestic chimneys and of smoke and grit from industrial establishments. In the latter group we were interested to note the inclusion of a paper on "Measurement of Dust Emission from Steelmaking Furnaces" because, as is well known, the development of new processes in the steel industry has created new and serious dust and fume emission problems. In the afternoon participants in the conference considered reports on the working of the Clean Air Act and the discussion of that subject continued the following morning. The reports were based upon the answers to questionnaires sent out to local authorities. In the domestic sense, especially in the creation of "smoke control areas," progress so far has been disappointingly slow. It may be, however, that no want of desire to get on with the job upon the part of local authorities is indicated. Staff shortages may be holding authorities back and there may be felt a need to try out new administrative procedures cautiously to begin with. Industrially, too, some members of the Society may feel that progress could have been faster. They under-estimate, we suggest, the time needed to replace old plant ill-designed to prevent the emission of smoke, to re-educate stokers who have never before had to bother much about using methods of stoking which will reduce smoke emission, to install measuring equipment, and the like.

RECRUITMENT OF SCIENTISTS AND ENGINEERS TO GOVERNMENT SERVICE

Recently there was published the Report of Her Majesty's Civil Service Commissioners for the period April 1, 1959, to March 31, 1960. That part of the burden of its song which attracted particular attention in the press was the complaint that the year was a difficult one for recruitment to the scientific, professional and technical classes in the Civil Service. "For some years Your Commissioners have failed to fill an adequate proportion of the notified vacancies in the Scientific classes, and the deficiencies have been most marked in the Scientific Officer grade. The results for the year 1959-1960 show that the situation has worsened and the present position gives rise to grave disquiet . . . the average quality of . . . candidates . . . in the Scientific Officer and Senior Scientific Officer grades has noticeably deteriorated. . . . Recruitment to the Scientific Officer grade continues to be far below what is required to fill the vacancies." In the professional classes there are major shortages amongst civil engineers, and certain classes of mechanical and electrical engineers "particularly electrical and electronics specialists".

The Department of Scientific and Industrial Research has since commented on this report. That department does not seem to be either seriously worried or seriously incommoded by difficulties in recruiting staff and feels that it has not suffered disproportionately in comparison with industry. Certain laboratories, however, are short of some grades. When a laboratory is expanding some of its work rather rapidly as, for example, the Road Research Laboratory is, it may find difficulty in filling some of the new posts created simply because the subject to be covered is a new one in which few young graduates will have had either training or experience. Again reorientation of the work of a laboratory, as has occurred recently at the National Chemical Laboratory, may lead to a very similar difficulty in recruiting staff. Unfortunately, however, there is another cause of difficulty which is not at all easy to put right. As the D.S.I.R. puts it, "there are fashions in science, as in everything else, and today there is not, perhaps, so much attraction to university graduates to embark on the courses of classical science as there used to be". To some such cause can be traced difficulties which the Ship Hydrodynamics Laboratory of the National Physical Laboratory is experiencing in recruiting staff. The shortage is general in the shipbuilding industry. Similarly few graduates seem to be much interested in researches into noise and, indeed, teaching of the subject is rarely continued into the third year at universities.

The situation invites the comment that though one may argue that too much money and effort is being expended upon, for example, space research and too little upon less spectacular work it will be of little use directing more funds to the latter if young and coming scientists and engineers cannot be attracted to work in those unfashionable fields. By reducing this country's expenditure on space research it is by no means sure that more scientists would be made available for work in other fields. More probably those displaced would emigrate to some country where they could continue to work in their chosen field.

FUEL EFFICIENCY PROGRESS SURVEY

The National Industrial Fuel Efficiency Service has issued its sixth progress survey which covers the period from April 1, 1959, to March 31, 1960. The report notes that the year under review is the first of the second quinquennium for which N.I.F.E.S. is being sponsored by the fuel industries and quotes the estimate of savings over the years 1955 to 1958, given by Sir Dennis Proctor, of which 5,500,000 tons of fuel are due to the growth of fuel efficiency. Tabular statements illustrate the development of the Service and give the number of companies for whom N.I.F.E.S. carried out heat and power surveys and special advisory service or had regular service agreements as 5084. It is mentioned that nearly half of the factories using over 1000 tons of fuel per annum have requested advice from the service and that much of the work is on a continuing basis. Another table gives a summarised record of work and it is noted that the duration of contracts has increased and that the reason submitted is the increasing complexity of the problems to be solved. A further table divides the contracts into industrial groupings. Attention is called in the report, to the number of measuring instruments which are available and which are becoming increasingly essential since problems are more difficult, so that there is a limit to the effectiveness of visual observation. An analysis of the results of heat and power surveys records a mean saving of 20·5 per cent for the years 1954-60 and indicates that as much as 1 ton out of 5 tons of fuel can be saved. As a result of the work of the Service it has been asked to extend the range of its surveys and a natural extension has been to start investigations into questions of water economy, grit emission and industrial noise.

No doubt the savings effected as a result of surveys carried out by Service engineers have been achieved, in many instances, by minor alterations to existing plant at a comparatively low cost while to comply with other recommendations has represented a major reconstruction

and the incurrence of considerable capital expenditure. The average improvement of 20·5 per cent in fuel consumption claimed in the report does indicate there must have been scope for improvement in the design of the original plant. This prompts the thought that a careful analysis of the large number of survey reports, made during the six years of the existence of N.I.F.E.S., upon a wide range of plant, processes and operating conditions should enable the Service to be in a position to offer invaluable advice to the designers of new plant. Such advice based upon the results of practical experience may modify theoretical planning to ensure a higher initial efficiency and leave room for only marginal gains to be made by on the spot surveys. It is of interest to note that at least one firm has asked the advice of N.I.F.E.S. upon the operational aspects of a new plant.

NEW CUNARD LINER

The speculation, argument and counter argument which have been in the air, since the report of the Chandos Committee was presented to Parliament on June 1, have been resolved, at least, temporarily, by the announcement that the Government has agreed to provide assistance towards the building of a liner to replace the "Queen Mary". It will be recalled that the Chandos Committee, acting upon professional advice and after discussions with the Cunard Company, agreed that an economic liner to satisfy conditions existing in the North Atlantic passenger service would have a gross tonnage of 75,000, and would cost a maximum of £30,000,000 of which the Cunard Company would make available £12,000,000 leaving the balance to be provided by a Government loan. Financial arrangements proposed that the ship should be operated by the Cunard Company but owned by a separate company and that interest at 4½ per cent would be paid. Other provisions concerned redemption by operating a sinking fund, depreciation at the rate of one twenty-fifth of the capital cost per annum and the adjustment of interest rates according to circumstances. Although detailed arrangements will not be known until Parliament has been informed, the Ministry of Transport has discussed and provisionally agreed with the Cunard Company the terms and extent of the Government assistance. The extent will be similar to that suggested by the Chandos Committee but the terms and form of the loan will differ.

With the announcement that a loan will be forthcoming it is clear that the Government after considering the challenge of aircraft and supersonic travel has decided that an assessment of the trends in trans-Atlantic travel justify the replacement of the "Queen Mary". With the green light to proceed, no doubt the Cunard Company will go ahead with the design of the ship and prepare specifications of hull and machinery in preparation for inviting tenders from those shipyards capable of building such a ship. Naturally with such a contract in the offing, claims have been put forward, on the basis of unemployment figures, for the liner to be built in a particular yard; however the results of open competitive tender should prevail. Too much has been made of the effect of such an order. The building of such a large ship, although it will have a beneficial effect locally, will not cure shipbuilding ills. A cure would require a steady flow of orders for ships for many trades. But, it will be interesting to hear the reaction of other shipowners to the loan; for the Cunard Company is not the only shipping line in need of assistance to combat the threat of subsidies and other forms of help given to their national fleets by foreign governments.

SECOND " NEW RIVER " IN LONDON

The Metropolitan Water Board's new tunnel, which extends for nearly 19 miles under the streets of London, was recently inaugurated after about ten years of development work and of actual construction. It was described on page 578 of last week's issue. From all points of view, the tunnel is an exceptionally noteworthy piece of constructional work. No similar scheme of comparable magnitude has been carried out in London for many years, but the scale of the work alone is not its most interesting feature. The function of the tunnel — to carry "raw" Thames water to the Lee Valley — and the reasons why this is necessary were explained in our article. Suffice it to say here that it has a capacity of 120 million gallons per day, and its diameter internally is 8ft 6in.

Its engineering interest centres on the use of unbolted concrete segments to line the tunnel. Originally, steel pipes were to have been placed inside the tunnel, but they were dispensed with, thus effecting a very great saving in cost. By arranging pumps at the Lee Valley end, and thus having gravity flow in the tunnel, this saving was possible and further savings in pumping costs were also achieved. The behaviour of the unbolted lining was examined exhaustively, and similar tunnels will be found on other of the Board's schemes, for their design and construction is now well understood. On the constructional side, the development of the "drumdigger" shield enabled rates of progress of up to 360ft per week to be achieved, which is probably a record for soft ground tunnelling. Indeed the whole concept in all its aspects is a fine example of progressive thought and development. Finally, we note that the cost is quoted as £4,300,000, whereas an estimate of over £5,000,000 was originally given!

The Engineer—100 Years Ago (OCTOBER 12, 1860)

" THE DUBLIN AND HOLYHEAD STEAMERS "

" The fast mail-packets now plying between Dublin and Holyhead mark another era in steam navigation ; not because they embody new principles either of construction or economy, but because they show that, with such new principles or without them, it answers useful commercial ends to build vessels that shall perform sea passages at half the rate at which express railway trains travel. When the new postal system between London and Dublin was inaugurated a few days since, it was found that, with the most carefully-contrived arrangements, the mails could not be conveyed from London to Liverpool at a greater average speed than 45 miles an hour without, and 40 with, stoppages ; and as a few stoppages are necessities in the case of land transit over hundreds of miles, the lower rate of travel is practically the maximum. It has now been proved that over-sea steam vessels can, in all but the worst weather, exceed the half of this ; for the Ulster, Leinster, and Connaught are now steaming between Dublin and Holyhead at an average speed of 20½ miles per hour. The average speed, therefore, of our fastest mail steamers is rather more than half that of our fastest mail trains. This is an intelligible and notable point to have arrived at in the history of land and sea transit ; and when we consider the difficulties which beset the floating body, and which increase so enormously as the speed increases, we think the result is highly creditable to Messrs. Laird and Messrs. Samuda, and to naval architects throughout the country. In saying this we would not lose sight of the engineers, Messrs. James Watt and Company, and Messrs. Ravenhill and Salkeld, who have strenuously co-operated with the builders of the vessels towards the attainment of so good a result ; but the primary credit of a highly-successful steamship of entirely novel proportions must, we honestly think, be due to the designer of her lines."

Kincardine Power Station

On October 12 Her Majesty The Queen opened Kincardine power station, on the River Forth. With an installed capacity of 360MW, to be increased to 760MW by 1963, Kincardine is the largest power station of the South of Scotland Electricity Board. It is sited on land reclaimed from the tidal foreshore of the river. By pumping ash and dust slurry from the station to Longannet, 3 miles down river, it is planned to reclaim another 280 acres from the foreshore and ultimately to make it available for agriculture.

KINCARDINE power station, on the north bank of the River Forth and about 15 miles west of Dumfermline, was originally planned by the former British Electricity Authority to meet the growing demand for electrical power in central Scotland. The project became the responsibility of the South of Scotland Electricity Board which came into being on April 1, 1955, under the Electricity Reorganisation (Scotland) Act, 1954, and it was on the same day that statutory consent to build the station was received by the newly formed Board.

Originally the intention was to install six 120MW sets operating at the advanced steam conditions of 1500 lb per square inch and 1000 deg. Fah. with reheat to 1000 deg. Fah. Subsequently it was decided that these conditions should apply only to the first three sets and that the second group, to be added later, should be two 200MW sets to operate at the even higher steam conditions of 2350 lb per square inch and 1050 deg. Fah. with reheat to 1000 deg. Fah.

Work on site began in June, 1955, and the three 120MW generating units were commissioned in 1958, 1959 and 1960 respectively. The first 200MW unit is due to be commissioned in 1962 and the second in 1963 when the station will reach its ultimate generating capacity of 760MW.

The Site

The choice of the site, on the upstream side of the Kincardine-on-Forth road bridge was influenced by the proximity of adequate supplies of coal and cooling water. Short-haulage coal is planned to be available from the Fife and Clackmannan coal field because of the National Coal Board's proposed expansion programme there. At all stages of the tide there will be enough cooling water for the requirements of the 760MW station without requiring cooling towers; the circulating-water pumping costs should be low since the basement level is +5O.D., the normal tidal range being 17ft with a recorded extreme of 25ft.

Before 1822 the site formed part of the tidal foreshore of the River Forth. At that date about 150 acres were enclosed by an embankment, the land reclaimed sloping fairly uniformly towards the river. As additional security against flooding, the embankment now has been raised and strengthened. The embankment work includes a protective breastwork in the form of precast concrete blocks set between cast-in-situ beams surmounted by a wave deflector wall.

As coal was known to have been worked under the foreshore before the reclamation, it was at first proposed to locate the main building of the power station towards the west end of the site. Borings showed, however, that rockhead was nearly 100ft below ground level at that end of the site, while to the east of the centre of the site the rock was but 10ft below ground level. Confirmatory deep bores were put down to settle whether the old coal workings extended below this area. These bores proved that the coal seams, found in the carboniferous sandstone which underlies the site, had not been worked and this position was chosen for the main building. Sidings, coal store, switching compounds and ancillary buildings make up the total station area to about 137 acres.

Because the site lies below high water level and is comparatively flat with a high water-table, drainage has received special consideration. The site drains, including rain water from the roofs of buildings and the effluent from various items of plant, lead to a surface-water pump house via an underground storage tank of about 250,000 gallons capacity designed to fill when the flow in the main drain exceeds a certain depth. At the pump house four 6000 g.p.m. pumps arranged to operate and cut out at predetermined water levels in the suction chamber, discharge the surface water through twin 36in diameter pipes to the river.

There is a sewage treatment plant consisting of the usual arrangement of settling tank, septic tanks, humus beds and filter beds, the wet sewage being pumped from septic tanks into the filter beds by compressed air. This pump can also empty the sludge into tankers when required.

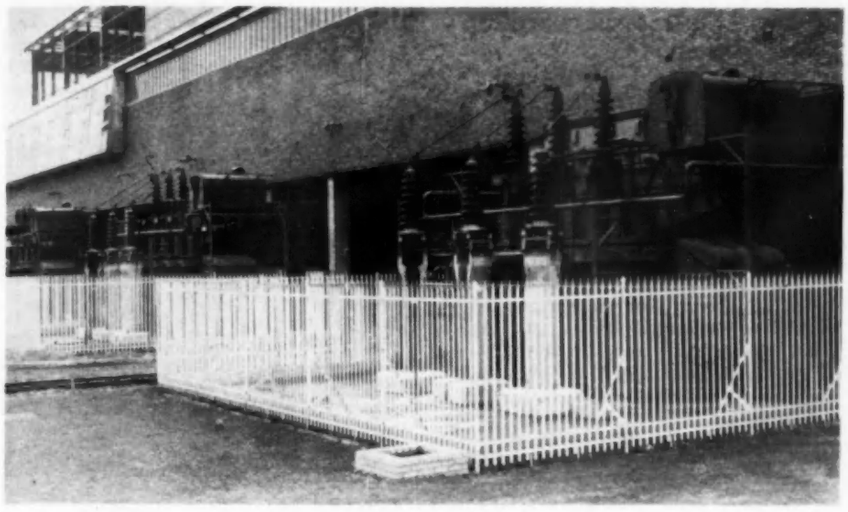
The site, on the north bank of the river, is laid out with the coal store on the north-west, the 275kV and 132kV switching compounds in the centre and the main and auxiliary building on the south-east. Within the south-eastern boundary of the site are the reservoir, the water treatment plant, ash- and dust-handling plant and fuel oil pumphouse and the circulating water pumphouse in the extreme south.

The first chimney, which serves the three 120MW units already installed, is 400ft high with an inside diameter of 24ft at the top. It is lined with 4½in acid-resisting brick, the main structure being of brickwork on a concrete base founded on rock. Another chimney of similar construction is being built for the two 200MW units to be installed in the second half of the station.

The main building and the auxiliary buildings are steel framed with a light cladding of aluminium and glass and with brickwork for the lower parts of the walls. In the main building the boilers are slung near roof level from the structural steelwork which is shop welded and site riveted, the maximum design load on any one column carrying the first three boilers being 1760 tons. All the heavier columns are of welded box section and all columns have mass concrete footings founded on rock. The station basement slab consists of mass concrete with culverts 8ft 6in square running longitudinally through the station to carry the circulating water.

As illustrated here the three 120MW turbo-generators are installed transversely in the turbine house, but the fourth and fifth 200MW sets, because of their length, will be arranged longitudinally. The boiler house is to the east of the turbine house and is separated from it by an annexe containing the feed pumps, control rooms, de-aerators, and reserve feed tanks. Beyond the boiler house is the bunker bay which also contains the milling plant. Switchgear and transformer annexes flank the main station building, that on the west side containing the main electrical control room. The generator transformers (as illustrated) stand outside the building on the west side, facing the grid substation. The precipitators and induced draught fans are to the east of the main building, and beyond them are the main flue, chimneys, and the ash and dust plant house. The adminstration and workshop block is on the south side and lies between the main building and the river. Space

Kincardine power station (South of Scotland Electricity Board) on the River Forth. The present generating capacity of 360MW will be increased to 760MW by 1963



Three 144MVA generator transformers at Kincardine power station

heating is effected by an 864kW floor warming installation operated as an off-peak load.

Circulating Water System.—The intake headworks are situated some 500ft out in the River Forth at the downstream end and triple intake culverts connect the headworks with the pump house. The circulating water pump house will house six 65,000 g.p.m. vertical-spindle centrifugal pumps, four of which are being installed initially. Circulating water is taken from the pump house to the condensers through twin reinforced culverts and thence to the outfall by similar culverts. The outfall is situated on the river bank, about 2700ft upstream from the headworks.

Coal Handling System.—Coal is transported to the station by rail and exchange sidings have been built, providing facilities for handling up to 375 wagons per day. Marshalling of the wagons is carried out by diesel-electric locomotives which feed wagons to the tippler and filler pit approach tracks. The maximum annual tonnage of coal to be handled is estimated as 2,200,000 for the complete station.

Two side-discharge tipplers incorporating weighbridges, capable of handling 24½ ton capacity wagons, are installed for discharging coal from flat-bottomed wagons. " Beetles " are used for propelling the wagons on to the tippler platforms and marshalling the empties.

Hopper bottom wagons of up to 24½ tons capacity are discharged into the three filler pits. Trains of wagons are propelled by the locomotives and each wagon is positioned on to, first, the weighbridge and then over the rack hopper, facilities being available for vibrating the wagons if necessary to dislodge the coal. A dust collecting plant is provided. A road hopper can be used for the discharge of coal from road lorries if desired.

A system of duplicate 600-tons-per-hour belt conveyers, remotely controlled, take the coal from the various receiving hoppers to a central point where it can be screened and crushed if required. From there further duplicate conveyors take the coal via trash screens and belt weighers to the boiler bunkers or, alternatively, the coal can be conveyed to and from a stock pile by lines of 1200 tons per hour conveyors. Three bulldozers are used for spreading and reclaiming the coal on the store.

Boilers

The first three boilers have a rated capacity of 860,000 lb of steam per hour with superheater outlet conditions of 1600 lb per square inch, 1010 deg. Fah., and after passing through the high-pressure stages of the turbine the steam is reheated to 1005 deg F h. The fourth and fifth boilers will be rated at 1,350,000 lb of steam per hour with superheater outlet conditions of 2400 pounds per square inch, 1050 deg. Fah, and the reheater outlet temperature will be 1005 deg. Fah. Each boiler is of the natural circulation water tube radiant type with water-cooled combustion chambers designed to burn pulverised coal of average calorific value, 9400 B.T.U. per pound with an ash content of up to 20 per cent.

On No. 1 boiler (International Combustion) the secondary superheater is situated at the outlet to the combustion chamber and, after leaving the secondary superheater, the flue gases traverse in succession the reheater, primary superheater and economiser in the rear pass of the boiler. Two forced-draught fans deliver air for combustion through two rotary regenerative air heaters.

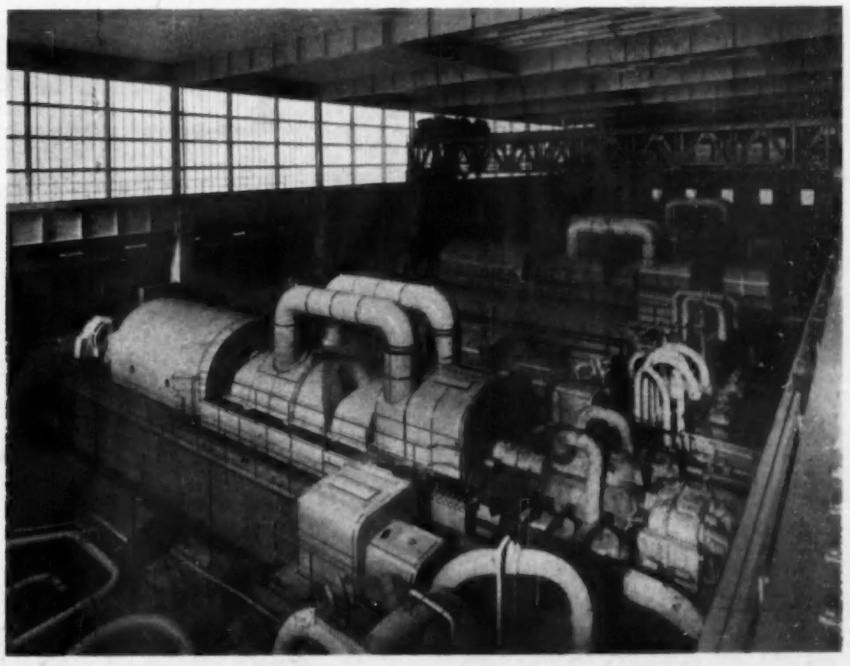
Main Particulars of Boiler Plant

	No. 1 Unit	Nos. 2 and 3 Units
Stop valve pressure, lb per square inch	1,600	1,600
Stop valve temperature, deg. Fah.	1,010	1,010
Reheat outlet temperature, deg. Fah.	1,005	1,005
Feedwater temperature, deg. Fah.	446	446
Combustion chamber volume, cubic feet	82,100	75,700
Furnace heating surface, square feet	16,295	11,740
Boiler heating surface, square feet	716	4,800
Primary superheater area, square feet	35,920	43,500
Secondary superheater area, square feet	7,540	Pendant 4,600 Radiant 9,450
Reheater surface area, square feet	13,700	40,600
Economiser, type	Gilled sleeve	Continuous steel tube
Economiser, heating surface, square feet	126,295	Main 39,000 Bypass 1,500
Air preheaters, type and No.	Rotary (2)	Rotary (2)
Air preheaters, heating surface (each) square feet	128,000	141,500

Mechanical dust collectors followed by electrostatic precipitators are provided to remove the dust from the gases before they are admitted to the two induced draught fans situated outdoors below the main flue, whence the gas is passed into the chimney.

The coal pulverising equipment consists of five mills, four of which can maintain maximum boiler load. They are suction mills with rollers running on a grinding ring, and the exhauster fans deliver the fuel to four sets of tilting burners situated at the corners of the combustion chamber for tangential firing. The superheater outlet temperature is controlled by spray desuperheaters arranged between the primary and the secondary sections of the superheater and the reheat outlet temperature is controlled by altering the angle of the burner tilt.

In Nos. 2 and 3 boilers (John Brown Land Boilers, Ltd.) the superheater arrangement differs from that adopted in No. 1 boiler described above, in that the first section of the secondary superheater is situated in the radiant zone at the top of the front of the wall and in platens suspended from the roof of the combustion chamber. The remaining section is in the convection zone, followed by the primary superheater and reheater arranged in parallel gas paths before the economiser. The milling equipment (illustrated) consists of four high-speed horizontal-spindle attrition type pulverisers,



Three 120MW turbo-alternators are installed transversely in the turbine house of the Kincardine power station. The steam conditions at the turbine stop valves are 1500 lb per square inch gauge and 1000 deg. Fah. with reheat to 1000 deg. Fah.

each consisting of a combined mill and exhauster, which deliver pulverised fuel to sixteen burners in the front wall of the furnace. Three duplex pulverising mills are sufficient for full load operation. Whilst the superheater outlet temperature is controlled by water sprays, as in No. 1 boiler, the reheater outlet temperature is controlled by altering the proportion of gas flow over the reheater and primary superheater by means of dampers.

On the Nos. 4 and 5 boilers the primary superheater will be suspended at the top of the furnace in the radiant zone. The secondary superheater will be in the furnace exit, and in the rear pass the reheater and economiser will be so arranged that part of the economiser is in a parallel gas path with the reheater. The reheater outlet temperature will be controlled by proportioning the gas flow between it and the upper section of the economiser, while the superheater outlet temperature will be controlled by spray valves. These boilers will be equipped with six pressure type ball pulverising mills each equipped with its associated primary air fan, and five of the mills will develop full load.

Turbo-Alternators

The first three turbo-alternators are Parsons 120MW impulse-reaction, 3000 r.p.m. machines designed for steam conditions at the turbine stop valve of 1500 lb per square inch and 1000 deg. Fah. The turbines are three-cylinder, three-exhaust units, and the high-pressure cylinder is reversed, to minimise thrust problems. The shafts are solidly coupled with only one thrust bearing. After expanding through the high-pressure turbine the steam is reheated and enters the intermediate-pressure cylinder again at 1000 deg. Fah. The intermediate-pressure cylinder incorporates low-pressure blading for one-third of the steam flow and the remainder of the steam is expended in a double-flow low-pressure turbine. The condensers are designed for 28·9 in Hg. vacuum on normal conditions.

From the condensers the condensate is delivered by extraction pumps through two low-pressure heaters to a high-level deaerator. In the case of No. 1 unit, before entering the three high-pressure heaters, booster feed pumps raise the pressure of the condensate to 550 lb per square inch and after leaving the high-pressure heaters the feed water at 435 deg. Fah. is raised to a pressure of 1950 lb per square inch by the main boiler feed pumps. Nos. 2 and 3 units are provided with full head feed pumps positioned before the high-pressure heaters in place of the split pumping arrangement.

Each alternator is cooled by hydrogen at a pressure of 15 lb per square inch and the gas is cooled by distilled water in eight exchangers built in the stator casing.

The 200MW generators Nos. 4 and 5 will be G.E.C. four-cylinder, four-exhaust impulse sets. The turbine stop valve conditions will be 2350 lb per square inch, 1050 deg. Fah. and the reheat inlet temperature will be 1000 deg. Fah. The flow in the high-pressure turbine will be reversed and the shafts will be solidly coupled with only one thrust bearing. After the steam leaves the intermediate-pressure cylinder it will pass into two double-flow low-pressure turbines exhausting to twin condensers. A seven-stage feed heating plant will be provided and the feed pumps will be of the full-head duty type installed before the high-pressure feed heaters. The generators will be cooled by hydrogen at 50 lb per square inch and, in addition, the stator conductors will be water-cooled.

Ash Handling System

In the completed station, up to 200 tons of furnace ash and 1300 tons of fly ash will be handled daily. The ash collected in the furnace hoppers is sluiced by high-pressure water jets to sumps from where it is extracted, drained, and loaded on to lorries by grabbing cranes. The fly ash is conveyed from the rear passes of the boilers by compressed air and from the mechanical and electrostatic precipitator hoppers by air slides to a pneumatic pump whence it is blown into the bunkers in the ash plant house.

The ash from these bunkers is fed by variable-speed rotary feeders into mixers below. Sea-water is pumped from the circulating water system, at a controlled rate to maintain a specified level in the mixers. A gamma-ray density meter measures the concentration of the mixture in the outlet pipe; its readings used to control the variable-speed rotary feeders which keep the slurry concentration close to the required value of 3½ lb of dust per gallon of water. There are three disposal pumps (each with a slurry capacity of 2030 gallons per minute) to pump the slurry through two asbestos-cement pipes to Longannet, about three miles downstream. Control of the fly ash handling plant is exercised from panels equipped with mimic diagrams and remote push-button selection with sequence interlock.

One of the major works arising out of the need to dispose of large quantities of ash and dust is the construction of the disposal site at Longannet. The site, which covers nearly 280 acres, will eventually be reclaimed from the foreshore of the River Forth and made available for agriculture.

Auxiliary Electrical Plant

Busbars in trunking connect the first three generators to the 144MVA, 13·8/132kV generator transformers equipped with on-load tap changing gear. Oil-filled cables connect the transformers to the 132kV air blast circuit breakers in the outdoor switching station. The four and fifth units will be connected through 225MVA, 16/275kV generator transformers to a 275kV switching station. Overhead lines will connect the transformers to the air-blast circuit breakers.

The main plant auxiliaries are supplied from unit transformers; in addition, 132/6·6kV transformers are provided for starting and station services. The 6·6kV switchgear is airbreak equipment and is located in two switch annexes running the length of the turbine house. In these annexes and switch houses adjacent to the various load centres outside the main building, are located the 415V switchboards. In general, motors up to 300 h.p. are supplied at 415V, those of larger size at 6·6kV.

The electrical control room is located centrally in the turbine house electrical annexe and houses the controls and indications for all 275kV circuit breakers and the 6·6kV auxiliary system feeders.

The consulting engineers for Kincardine power station are Kennedy and Donkin, London, in association with the consulting civil engineers James Williamson and Partners, Glasgow. The architects are Robert Matthew and Johnson-Marshall, Edinburgh.

Nos. 2 and 3 boilers are each equipped with four pulverised fuel mills as shown here

Main Contractors

Some of the main contractors are listed below. Preliminary civil engineering works, Mowlem (Scotland), Ltd. Civil engineering works for main and ancillary buildings, Holloway Brothers (London), Ltd., and Holloways Scottish Constructions, Ltd. Structural steelwork for main building, Redpath, Brown and Co., Ltd., in association with Sir William Arrol and Co., Ltd., P. and W. MacLellan, Ltd. and Alexander Findlay and Co., Ltd. Structural steelwork for ancillary buildings, Redpath, Brown and Co., Ltd. River works and site main drainage, Yorkshire Hennebique Contracting Company, Ltd. Superstructure of main and ancillary buildings, The Mitchell Construction Company, Ltd. Chimney, P. C. Richardson and Co., Ltd. Ash disposal works, Mowlem (Scotland), Ltd. Concrete storage tank, Preload, Ltd. Sidings, Thos Summerson and Sons, Ltd. Boiler plant, International Combustion, Ltd. (No. 1), John Brown (Land Boilers), Ltd. (Nos. 2 and 3), Babcock and Wilcox, Ltd. (Nos. 4 and 5). Generating plant, C. A. Parsons and Co., Ltd. (Nos 1, 2 and 3), General Electric Company, Ltd. (No,. 4 and 5). Main crane, Sir William Arrol and Co., Ltd. Boiler feed pumps, Mather and Platt, Ltd. (No. 1), Harland Engineering Company, Ltd. (Nos. 2 and 3). Pipework, Aiton and Co., Ltd. C.W. pumps and motors, Drysdale and Co., Ltd. C.W. screening plant, J. Blakeborough and Son, Ltd. Coal handling plant, Simon-Carves, Ltd. Ash handling plant, John Thompson Industrial Constructions, Ltd. Demineralisation plant, Permutit Company, Ltd. Chlorination plant, Wallac and Tiernan, Ltd. Shunting locomotives, Ruston and Hornsby, Ltd. Unit control boards, Bailey Meters and Controls, Ltd. Main switchgear (132kV), Metropolitan-Vickers Electrical Company, Ltd. Auxiliary switchgear (6·6kV), English Electric Company, Ltd. (415V), Whipp and Bourne, Ltd., James Scott and Co., (Electrical Engineers), Ltd. Generator transformers, Bruce Peebles and Co., Ltd. Unit and starting transformers, Bonar Long and Co., Ltd. Station transformers, Associated Electrical Industries, Ltd.

British Railways Electrification Conference

No. II—(*Concluded from page 589, October 7*)

Two further papers read to the British Railways Electrification Conference in London last week are abstracted below. The conference proceedings, which included technical visits as well as discussion of papers, ended on October 7.

The Power Supply

THE following extracts are from a paper on the power supply read to the conference by Mr. W. J. Webb, Assistant Electrical Engineer (Systems), British Railways Central Staff.

The power supplies required by the British Transport Commission for the 50 c/s single-phase electrification of its surface railway lines are obtained from the Central Electricity Generating Board. Normally the supplies are obtained from the 132kV National Grid System but in some localities the supplies are from lower voltage sources.

The supplies are taken by the railway in duplicate as single-phase current at 25kV through 132/25kV transformers supplied by the supply authority. These transformers are normally banked with existing Area Electricity Boards' supply transformers utilising a common 132kV circuit breaker. The supplies are taken to railway feeder stations spaced 20-30 miles apart and the supplies at any one feeder station are given at the same phase. Supplies between adjacent stations are not paralleled, which enables the electricity authority to have the facility of balancing the railway load between the three phases of its system whilst avoiding possible difficulties in regard to protection and load transfer for the 132kV system.

At the present time the Commission has three main schemes of electrification in hand, namely London Midland Region main line, Glasgow suburban and the Eastern Region suburban aggregating some 790 route miles comprising some 2500 single-track miles. The total demand for all the schemes, allowing for diversity, will be of the order of 200MW and the annual consumption about 950 million units.

The London Midland Region main line scheme has very special merit in that it caters for all classes of traffic from main line express to heavy goods and a load factor of over 65 per cent is expected to result overall for the year. Consideration is still being given to variations which would have the effect of further improving the load factor.

For the electrified lines included in the electrification of the Glasgow suburban area the power supplies are derived wholly from the 132kV systems of the South of Scotland Electricity Board and the North of Scotland Hydro-electric Board. The supplies are taken at four points at 25kV single phase for distribution to the overhead traction system. For the inner area of the scheme due to severely restricting tunnel and bridge clearances the lines are fed at the reduced voltage of 6·25kV. These 6·25kV supplies are obtained from the normal 25kV supplies by means of step-down transformers provided by the Commission and installed at sub-feeder stations.

The lines from Liverpool Street to Southend and Chelmsford are at present electrified on the 1500V d.c. overhead system and the conversion of these lines to operation at 6·25kV single-phase presents a special problem. Although the adoption of 6·25kV as the nominal voltage enables the insulators to remain generally unchanged, as the majority of the existing types of 1500V d.c. insulators are suitable for working at 6·25kV a.c., nevertheless a separate single-phase a.c. distribution system has to be established for the supply of the requisite power and it is necessary to change all the track feeder cables. All this work has to be carried out without disturbance to the running of the existing electric train services on a route which serves one of the busiest of the London termini. Where applicable the existing 33kV three-phase supplies are being used by the installation of step down transformers.

Where these 33/6·25kV transformers are supplied from the existing 33kV three-phase system the transformers are of the single-phase type, and the transformers at the ends of the same section but installed in adjoining feeder stations are at the same phase, which has the advantage of enabling the overhead supplies to be paralleled on the section. Elsewhere where 6·25kV supplies are derived from the Area Board's 33kV network Scott-connected transformers are used to provide a better balance of the railway load between the three phases of the supply system than would be the case if single-phase transformers were used.

Feeder Stations.—There can be no general answer to the question of the value to be adopted for the distance between the points of supply to the overhead contact system. Primarily the distance is determined from consideration of the traffic to be handled, the performance required of the electric tractors and the electrical characteristics of the overhead and supply systems. Such considerations result in an optimum spacing which it is not often possible to achieve and the desirability of locating the feeder stations at strategic points such as junctions or route intersections frequently results in a shorter spacing being used.

Again, the feeder stations are preferably situated in close proximity to Grid sub-stations in order to avoid the disadvantages of long feeders. Generally the Grid substations are of necessity located near to the large towns, which in this country are situated relatively close together. In France the larger towns are further apart which enables a wider spacing to be used. The result of the foregoing consideration is that for the Commission lines the average distance works out at about 25 miles for a nominal line voltage of 25kV.

For the Commission's 50 c/s electrified lines, the size of the overhead conductors has been chosen to be equivalent to a copper conductor of 0·222 square inch. On some routes (in connection with the measures adopted to limit the voltage induced by the traction currents in nearly parallel-running telecommunication cables) booster transformers with return conductors are installed. The size of the return conductors varies from 0·22 square inch for the heaviest loaded lines down to 0·085 for those lightly loaded.

Having regard to the position of the conductors relative to the track, the values of the impedance of the overhead line used in the calculations are as follows : 0·47 ohm per mile per two-track length where no booster transformers and return conductors are installed, and 0·7 ohm per mile per two-track length with booster transformers and return conductors.

With these typical impedances, it can be shown that for a 25-mile spacing between railway feeder stations and with booster transformers and return conductors installed, this spacing is suitable for working a service of ten trains an hour at an average speed of 60 m.p.h. when hauled by electric locomotives each taking the maximum accelerating current of 270A. This is on the basis of a minimum voltage at the locomotives of 16·5kV for a nominal line pressure of 25kV.

Calculations for the 6·25kV system show that for the conditions where booster transformers and return conductors are installed the ideal spacing for this lower voltage system is about 5½ miles on the basis of a maximum value of the peak accelerating current of 1050A per train and on the assumption that both ends of the overhead line section are fed in parallel.

The Power Circuit.—The supplies from the Central Electricity Generating Board, which are given via stepdown 132/25kV single-phase transformers, are normally taken in duplicate and are fed to the railway feeder stations usually through concentric 25kV cables, but overhead lines are used where circumstances permit. Fig. 2 shows the

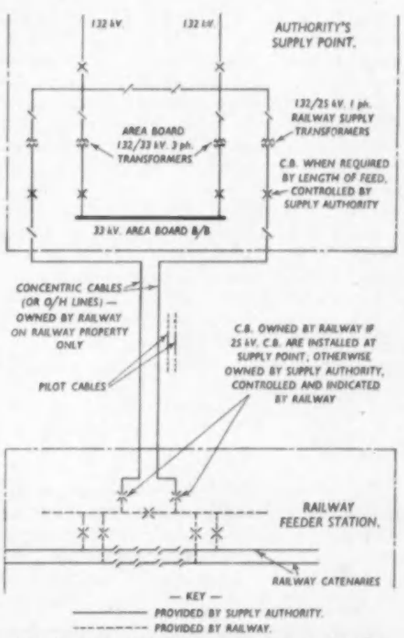

132 kV.
132 kV.
AUTHORITY'S SUPPLY POINT.
AREA BOARD 132/33 kV. 3 ph. TRANSFORMERS
132/25 kV. 1 ph. RAILWAY SUPPLY TRANSFORMERS
C.B. WHEN REQUIRED BY LENGTH OF FEED, CONTROLLED BY SUPPLY AUTHORITY
33 kV. AREA BOARD B/B
CONCENTRIC CABLES (OR O/H LINES) — OWNED BY RAILWAY ON RAILWAY PROPERTY ONLY
PILOT CABLES
C.B. OWNED BY RAILWAY IF 25 kV. C.B. ARE INSTALLED AT SUPPLY POINT; OTHERWISE OWNED BY SUPPLY AUTHORITY, CONTROLLED AND INDICATED BY RAILWAY
RAILWAY FEEDER STATION.
RAILWAY CATENARIES
— KEY —
PROVIDED BY SUPPLY AUTHORITY.
PROVIDED BY RAILWAY.

Fig. 2—Typical 25kV power supply installation

arrangement of a typical 25kV a.c. power supply installation.

At the railway feeder stations the inner conductor of the concentric cable is taken through a single-pole circuit breaker to a busbar from which the supply is distributed through single-pole circuit breaker equipments to the overhead conductor lines. The outer conductor of the concentric cable is taken to a busbar designated the "earthy" busbar which is connected by insulated cables to the running rails. Pantographs fitted to the electric tractors collect the required traction current from the overhead lines and the return current passes via the wheels of the vehicle to the running rails and thence to the

supply point through the earthy bar connection.

For the operation of the protective system fitted to the circuit breaker equipments as well as for the protection of personnel an earth bar connected directly to an earth electrode is provided at each railway feeder station. At the C.E.G.B. end of the incoming feeder, earthing is provided through a spark gap—normally the 25kV supply is only earthed at the railway end. This is essential for the satisfactory operation of the railway signal track circuiting arrangements. The earth bar is directly connected to the earthy bar.

Midway between adjacent feeder stations, a neutral section is provided in the overhead lines to separate electrically the supplies at adjacent feeder stations. At this point a track sectioning cabin is provided containing a group of single-pole circuit breakers with a bus coupler switch to provide facilities for through feeding in the event of loss of supply at the feeder station on either side and also to enable full advantage to be taken of the conductivity of the conductors of parallel tracks and reduce voltage drops in the overhead lines. Midway between this position and the railway feeder station secondary track paralleling cabins are located for overhead line sectioning purposes. In this way the zone of disturbance caused by a fault is kept small and in the event of its being necessary to isolate a section of the overhead line because of a fault the length of the line affected is kept within an acceptable limit.

Circuit Breaker Equipments.—The standard arrangement is to take the 25kV supplies required from the C.E.G.B. 132kV three-phase network via 132/25kV single-phase transformers connected in parallel with the C.E.G.B. main three-phase transformers for bulk supplies to local undertakings and controlled by the same 132kV circuit breaker. To cater for the railway load a range of sizes of step down transformer is used, namely 15, 10, 7½ and 5MVA. The short circuit duty of the 132kV circuit at the point of supply ranges from 1500MVA to 3000MVA at large capacity stations. The supplies are given in duplicate and the short circuit duty at the railway feeder station busbars is as given in the following table.

Installed transformer capacity for supply to railway MVA	Short circuit level MVA
2×15	250—273
2×10	215—228
2×7½	168—174
2×5	116—125

The fault level for the switchgear in the track sectioning cabins attains the following values,

Position of T.S.C.	Short circuit level, MVA	
	Two track	Four track
Quarter distance	120	166
Mid point position	76	120

For the 25kV switchgear required to cover the above range of duty two short circuit ratings have been adopted viz. 300MVA and 150MVA. An impulse withstand test voltage of 200kV has been adopted for all 25kV switchgear. All switchgear is supplied to a common railway specification.

When the electrification project was commenced there existed in this country no proved design of 25kV single-phase equipment of the required capacity and duty suitable for railway service. Two designs were selected from the types offered by manufacturers. Both designs are cubicle type but in one the equipment is air insulated and in the other oil insulated. The air insulated type made by Fuller Electric, Ltd., is installed generally on the Eastern Region new electrification whilst the oil insulated type made by Switchgear and Cowans, Ltd., is installed generally on the London Midland and Scottish Regions. Both designs are solenoid operated and arranged for remote control by the supervisory control system and are fitted with fully interlocked hand operated isolators on both incoming and outgoing sides.

All 6·25kV circuit breaker equipments are of the oil insulated type. Those used on the Scottish Region are made by Switchgear and Cowans, Ltd., and follow the same general design as the 25kV oil insulated equipments. Those used on the Eastern Region are made by South Wales Switchgear, Ltd., and are of the truck-mounted type, arranged for isolation by vertical withdrawal. Both makes are solenoid operated and arranged for remote supervisory control.

The 25/6·25kV step down transformers, where installed, are protected either by a bias differential system or a restricted earth fault system of protection of conventional design. Definite minimum inverse time relay protection is fitted at the supply end of the 25kV feeders and on the h.v. side of the 25/6·25kV transformer.

Following normal practice, the supply transformers are provided with balanced earth fault protection on both the h.v. and l.v. sides, together with Buchholz winding temperature and high voltage overcurrent protection. The supply feeders are protected by a Merz-Price balanced voltage system of protection with provision for intertripping. The system is usually of the Solkor pattern.

The protection of the overhead contact system is of the definite distance impedance type similar to that which has been very successfully applied to the overhead contact system of both the French and Swedish railway electrification systems. The system has the advantage over an overcurrent system in that variation in tripping time is determined by variation of impedance instead of current magnitude. This is particularly advantageous in the case of faults to the overhead system where prolongation of the fault current necessary to give an overcurrent system time to act might severely damage the conductors. The system is backed up by a long-time thermal relay to provide for tripping on the occurrence of a long sustained overload.

Following British Railways' standard practice, all the circuit breakers used to control the overhead distribution system are remotely operated and indicated from centrally situated control stations by means of supervisory control equipment. In order to avoid magnetically induced disturbances from the traction currents affecting the proper working of the apparatus, a voice frequency system of signalling is employed. All switch operations are effected from a vertical mimic switchboard at the control station. The switchboard is formed of a mosaic of 1in squares on which the circuits of the overhead lines are represented by coloured lines, the switchgear being represented by " discrepancy " type switches inserted in their appropriate positions.

Booster Transformers.—The normal arrangement of the conductors (overhead wires and running rails) for the a.c. single-phase system of railway electrification forms an unbalanced circuit. The effect is that by magnetic induction the traction currents cause induced voltages to appear in neighbouring parallel conductors such as telecommunication cables, the effect varying directly with the traction currents. The decision to install booster transformers either with or without return conductors as a means of limiting the magnitude of the induced voltage has introduced special problems for power supply.

The booster transformers are, in effect, power current transformers with unity ratio and are used with their primary windings connected in series with the overhead line and with their secondaries connected either directly to the running rails (rail return type) or to a special return conductor (return conductor type).

The effects of the installation of booster transformers require particular study in order that an economic result can be achieved. The most important effect is the increase in impedance of the power circuit, which because of its influence on voltage drop on the distribution system requires special attention to ensure that the performance of the traction equipment is not adversely affected. There is also the effect on the action of the definite distance impedance protective system fitted to the track feeder equipment. Although the sensitivity of this equipment is increased to some extent by the increase in impedance per unit length, the step in impedance at the booster transformer itself causes the location of the fault by the system to be less exact.

There is also the effect on rail potential to earth. With the system with the booster transformers connected directly to the running rails the potential of the rail, when several trains are taking current, becomes progressively higher in steps until the feeder station is reached. For the system with return conductors, however, the value of this potential is highest at the individual train.

Over all these are the disadvantages of increased losses and consequently increased running costs. The following table gives characteristic values of the impedance for the system.

Normal system ohms/mile	System fitted with booster transformers: With direct connection to rails ohms/mile	System fitted with booster transformers: # With return conductors ohms/mile
Per single track : 0·75–0·85	1·16–1·40	1·4
Per double track : 0·445–0·5	0·58–0·70	0·70

The capacity of the booster transformers required depends on the length of the section to be fed by the transformers and whether direct rail connections or return conductors are to be employed, and on the mean value of the traction current. For the peak accelerating currents for the electric locomotives and multiple unit trains consideration of the induction compensating requirements results in a spacing of about 1 mile for booster transformers with direct rail connection and about 2 miles for transformers with return conductors.

Cables.—The incoming 25kV supplies from the C.E.G.B. are delivered to the railway feeder stations through two-core concentric pressure cables at 25kV to earth. The same type of cable is also used where connections are required between railway feeder stations. Generally the cables are of the oil-filled type but some are gas filled. This latter type, which has the advantage of a lower charging current, is favoured for tunnel use. Cables having copper conductors and lead alloy sheaths and also cables having aluminium conductors and corrugated aluminium sheaths have been installed.

At Crewe the incoming 25kV supply cables have copper conductors of 0·85 square inch cross sectional area but usually 0·50 square inch conductors are sufficient where the supply transformers are rated at 15MVA as at Crewe.

On the Colchester–Clacton–Walton electrification the 25kV cable terminations are of the outdoor sealing end type but on the London Midland and Scottish Regions and for the further schemes on the Eastern Region the 25kV concentric pressure type cables are connected to indoor type switchgear by means of oil immersed sealing ends.

On the Great Eastern electrified lines there are existing substations with interconnecting 33kV three-core cables. The lines will be converted to the a.c. system but the 33kV distribution system will be retained with modifications to permit of different feeding arrangements to suit the a.c. system as well as for the augmented traction loads. One of the existing 33kV three-core solid type cables will be extended with similar type cable but two additional 33kV cables will be installed. These latter two cables will be of the oil filled type with shaped aluminium conductors laid up without fillers and corrugated aluminium sheathed.

The Multiple-Unit Trains

A paper explaining the basis of the ratings selected for British Railways multiple-unit stock, and comparing the various designs, was presented by Mr. H. Willcock, Design Engineer (Standards), Chief Mechanical Engineer's Department, and Mr. C. J. Clemow, Senior Technical Assistant (m.u. equipment), Chief Electrical Engineer's Department, both of British Railways Central Staff. Extracts from this paper follow.

As soon as the decision to adopt the 25kV 50 c/s system had been taken, involving a decision to convert the existing Eastern Region 1500V d.c. suburban electrification to the new system, it was necessary to place on order a very large number of multiple-unit trains for important suburban electrifications based on the Eastern Region London terminals at Liverpool Street and Fenchurch Street, for the suburban requirements originating at Manchester (Piccadilly) Station, and for the electrification of the Glasgow suburban lines.

Experience already obtained with three types of equipment by the conversion of the Lancaster–Morecambe–Heysham line from 6600V 25 c/s to 6600V 50 c/s was of considerable value. This experience was limited to three of the four contractors with whom bulk orders were placed and very strenuous efforts on the part of all concerned were necessary to develop the situation so that a fleet of over 400 motor coaches could be available during 1960 making allowance for conversion, whereas only three equipments existed when orders for the fleet were placed at the beginning of 1957.

The suburban electrifications themselves differed considerably in character, both as regards station spacing and speed restrictions and the schedule speed considered to be commercially economical. The Chief Electrical Engineer's specification for the equipments, whilst bearing this aspect in mind, set out a single set of parameters, and made provision for some adjustment of the characteristics to meet the special requirements of particular services.

The performance requirements were stated as follows :

(*a*) Maximum service speed of 75 m.p.h. with wheels worn to 36⅝in diameter (40in new).

(*b*) Mean starting acceleration of 1·1 m.p.h.p.s. for a loaded four-coach unit.

(*c*) With 22·5kV/5·6kV line voltage, with half-worn wheels, with normal full seated passenger load, and observing all speed restrictions, ability to perform the following :

(i) Normal run from Liverpool Street to Southend (Victoria) in sixty minutes, with six intermediate stops of thirty seconds each, and with sufficient coasting to give 8 per cent make-up time.

The stops are approximately 6 miles apart and the duty represents a schedule speed of 40 m.p.h.

(ii) After two normal round trips as above, an emergency run from Shenfield to Southend (Victoria) and back without any coasting and with six intermediate stops of twenty seconds each on each trip.

The stops are approximately 3 miles apart.

(*d*) Ability to start a loaded four-coach unit on a gradient of 1 in 70 with two motors cut out.

The rating was to be based on a four-coach unit tare weight of 144 tons. After the specification was issued, it was decided to use bogies of double bolster type to give improved riding qualities as compared with previous electric stock and to use thermal and sound insulation in the vehicle bodies. These increased the actual tare weight to 153 tons.

The use of the motor coach specified in a three-coach unit formation gives an increased performance compared with the four-coach unit and the ability to make more frequent stops without overloading for an inner suburban duty, such as on sections of the Glasgow suburban lines with 0·8 miles between stops. With the three-coach unit the acceleration is 1·35 m.p.h.p.s. The performances of three- and four-coach units are compared by the speed-distance curves shown in Fig. 3.

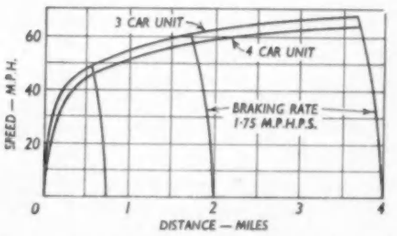


Fig. 3—Speed-distance curves on level track for multiple unit trains

The train equipments limit the maximum line current demand for each equipment to 250A on a 6·25kV line (62·5A on a 25kV line) by reducing the rate of acceleration between 20 m.p.h. and 30 m.p.h. The increase in running time is less than three seconds at each start.

Contracts placed cover equipments for 361 suburban multiple-unit trains (1301 vehicles) and equipments for the conversion of 124 existing d.c. suburban multiple-unit trains (404 vehicles) to a.c. working. Standardisation between the a.c. locomotives and multiple-unit trains extends to pantographs, circuit breakers, automatic power control and certain driver's controls and procedures. Many auxiliary machines, relays and contactors are interchangeable between certain locomotives and multiple unit-trains.

Electrical equipment.—All equipments have a single forced oil air blast cooled main transformer with a primary winding made up of four equal sections and an electro-pneumatic changeover switch to enable these sections to be connected in series for operation on 25kV or in parallel for 6·25kV. An additional winding supplies auxiliary equipment at 240V.

Tap-changing is carried out on the secondary side by air break contactors, either camshaft operated, or in the form of electro-pneumatic unit switches, or in combinations of both. The use of these forms of tap-changer is providing a useful comparison. The limitation of circulating current between transformer tappings during tap-changing is obtained by chokes or resistors or both, which are also used to obtain intermediate notches between full transformer tappings. Selection of an ideal scheme is a question of economics, involving consideration of energy loss, equipment weight, and complexity.

The decision to adopt the 25kV 50 c/s system occurred at a time when the semi-conductor rectifier was becoming a practical possibility for traction application and, as a result, one of the first contracts placed included germanium semiconductor rectifiers. As a result of further development, and satisfactory experience, further germanium rectifiers and also silicon rectifiers are now being introduced into service in quantity. Nevertheless three contracts include mercury-arc rectifiers, two using air cooling and one using water cooling, and these are performing with satisfaction.

The motors are essentially normal d.c. machines but with laminated commutating poles, and in some cases with external non-inductive resistors to divert the ripple current from the main field windings. The latter is provided to reduce the losses in the motor and to improve commutation, but experience does not indicate that it is an essential for good commutation. As on the locomotives, the ripple current is approximately 30 per cent at the rated motor current. All motors are axle hung with rubber resilient nose suspension. A proportion of the motors in service have roller axle suspension bearings, whereas most have sleeve bearings. Further operation will provide data to compare the merits of the two types of bearings.

Each equipment has four traction motors. To ensure good qualities of adhesion these motors are connected in parallel, or in pairs in series with their interconnections joined together, and in one case also connected to the transformer secondary midpoint. With

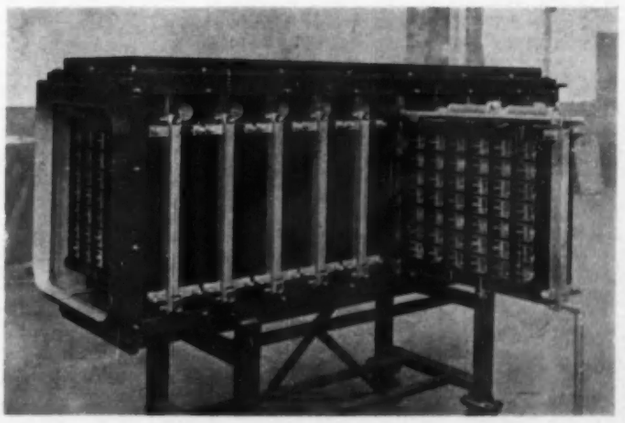


Fig. 4—Undercar germanium rectifier case for multiple-unit rolling stock, with ten trays containing forty-eight cells each

the series-parallel arrangement a measure of wheelslip control is provided on two types of equipment by detection of current in the centre interconnection caused by unbalance in motor speeds. The relays detecting this current prevent further progression in the tap-changing, and in one equipment a second relay cuts power off if the unbalance current increases still further. The value and method of application of wheelslip correction for multiple-unit trains is still under examination.

Auxiliaries.—The general form of the auxiliary circuits is common to all types of train. All power originates from the 240V auxiliary winding on the main transformer. This supply is used for all heating, main compressor, battery charger and all auxiliary motors that are not required to run when the line voltage is absent. Fan motors and the oil pump motor are single-phase induction motors with capacitor starting and running.

The main compressor is a Westinghouse type C.M.38 with a d.c. series motor supplied through a bridge rectifier. Battery chargers are not universally of one make but all are of the static type using a transductor-regulated rectifier. The battery charger charges a 110V d.c. battery and supplies the control circuits, all lighting and auxiliaries that are required to run when the line voltage is absent. The auxiliary compressor is a machine of approximately 5 c.f.m. displacement, driven by a 110V d.c. series motor. This machine runs only during the preparation of the train to charge the pantograph and air blast circuit breaker system, which is normally fed from the main reservoir system via a non-return valve.

Conversion of Liverpool Street–Shenfield–Southend Lines.—These lines were electrified from Liverpool Street to Shenfield and Chelmsford in 1949 using the 1500 d.c. system, and the electrification was extended to Southend in 1956. As part of the application of the 50 c/s a.c. system, the lines are being converted from the d.c. to the a.c. system. For various reasons, including the time available, it was decided to convert the d.c. multiple-unit trains to be suitable for a.c. working, by adding converting apparatus to the trailer coach adjacent to the motor coach in each unit. Ninety-two three-coach units and thirty-two four-coach units are involved, and a contract for the total of 124 conversion equipments was placed with Associated Electrical Industries, Ltd. The existing d.c. equipments are retained except for the pantographs, m.g. sets and certain minor items. Stone-Faiveley pantographs and A.E.I. blast circuit breakers are being supplied and the new contract covers the supply of main transformers and accessories similar to the standard equipments but with a simple secondary winding to give a 1500 d.c. output from the rectifiers. The rectifiers are of the air-cooled germanium semiconductor type, similar to those supplied by the same company for the Manchester–Crewe–Liverpool stock (Fig. 4).

Static battery chargers are to replace the original motor generator sets, as these are unsuitable for operation on the undulating current supply. New master controllers and other items of control gear are also supplied to bring the driving and preparation into line with the new a.c. units which will run over the same lines.

The thirty-two four-coach units are being additionally modified to use 110V d.c. instead of 52V for control and lighting, and to have the new standard thirty-six-way control couplers throughout.

Equipment for Railway Electrification

No. III—(*Concluded from page 592, October 7*)

The British Railways Electrification Exhibition at Battersea, held last week in connection with the railway electrification conference, closed on October 9. We review below a final selection of the exhibits by firms in the electrical industry, which accompanied an outdoor display of locomotives and rolling stock.

British Insulated Callender's Cables, Ltd.

EXHIBITS on this stand were drawn from the whole range of contributions by the B.I.C.C. Group to the railway modernisation programme. The display of overhead equipment components enabled visitors to compare items available in the earlier stages of 25kV a.c. traction development with the latest designs, showing how new materials have simplified and lightened them in various ways. The use of glass fibre rod with P.T.F.E. covering in the top tie of cantilever structures has enabled a porcelain insulator in this position to be dispensed with. Compression terminations have replaced clamp connections and bolts, and cantilever adjustment has been simplified. A structure with these features is seen in Fig. 12. Experience has also shown

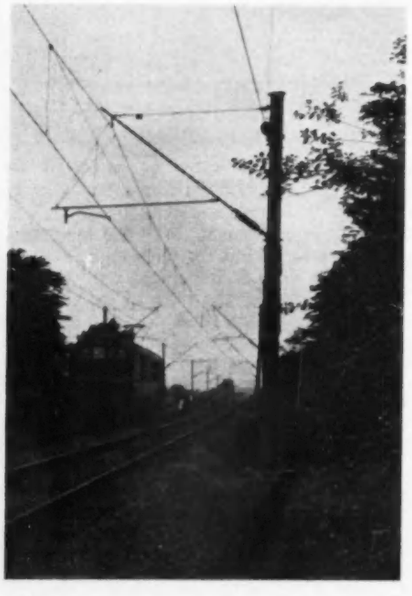


Fig. 12—Cantilever structure with P.T.F.E.-coated glass fibre rod in the top tie, dispensing with porcelain insulators in this position—B.I.C.C.

that in areas of lesser pollution galvanised tube can replace the copper-clad steel cantilever tubes used at the outset, and examples of this form of construction were seen on the stand. Further exhibits enabled the earlier form of section insulator, with porcelain insulators, to be compared with a current design again using glass fibre rod covered with P.T.F.E. Toughened glass runners are provided along the insulating portions to prevent cutting of the insulation by pantographs.

Cable exhibits on this stand covered screened, aluminium-sheathed telephone cables, oil-filled and gas-filled 25kV concentric track feeder cables, signalling cables, sealing ends, and cable joints.

Switchgear and Cowans, Ltd.

Fig. 13 shows a Switchgear and Cowans K.11 27·5kV, 330MVA oil circuit breaker switchboard as supplied to the London Midland Region and the Scottish Region of British Railways. One of these units was exhibited, together with the corresponding

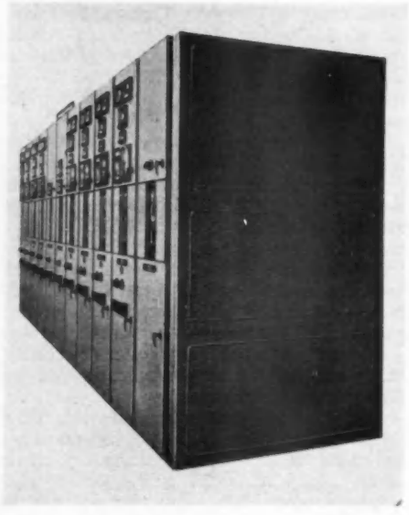


Fig. 13—Oil-insulated 25kV switchboard for feeder stations in the London Midland Region and Scottish Region—Switchgear and Cowans

B.41 breaker for 6·9kV, 165MVA. The K.11 and B.41 units are of similar style, being totally enclosed and oil-immersed with fixed oil circuit breakers, integral double isolation and earthing. Voltage transformers can be fitted to supply a voltage reference for the distance-measuring feeder protection used in the British Railways scheme. The oil circuit breaker is electrically closed by means of a solenoid through a trip-free linkage. A patented self-compensating interrupter maintains a consistently low level of arc energy over the interrupting range. Relay panels are fitted to each unit, and interlocks are repeated on a mechanically-operated mimic diagram. The tank raising and lowering mechanism is integral with the unit. Corresponding fuse units were shown for the control and protection of standby transformers which provide signalling supplies from the traction supply in emergency. These are similar in appearance and construction to the oil circuit breaker units, but in place of the circuit breaker a high breaking capacity cartridge fuse and oil switches are fitted. A 10A h.r.c. fuse is mounted in air across the lower end of the bushing from the two switch chambers, with the fuse clips enveloped by stress control spheres.

The Morgan Crucible Company, Ltd.

The carbon department of The Morgan Crucible Company, Ltd., includes in its display "Morganite" pantograph carbons as used for collector strips on Stone Faiveley

pantographs by British Railways (Fig. 14). This grade has been supplied by the company for many years to the Netherlands Railways. Known as "Link MY7D," it is a metal carbon (hard carbon incorporating copper lead) having an electrical resistance of $6{\cdot}5\times10^{-4}$ ohm-cm. Contact volt-drop per static contact is quoted as 0·9V. With the use of carbon current collectors, a considerable improvement in contact stability between overhead wire and collector is claimed. This is stated to be a result of the smoothness and polish developed on the wire with carbon compared with roughness caused on the wire contact surface when using metal collectors. This polishing of the wire surface is held to be the cause of longer life of the carbon current collector compared with the metal collector, and of a much reduced rate of wire wear. In the Stone-Faiveley pantograph illustrated, the pan swivels about an apparent pivot which is at, or slightly above, the contact surface of the pan and thereby ensures stable running. The metallised carbon strips are clamped with set screws to the collector frame.

Fig. 14—Carbon collector strips on a pan of the standard pantograph adopted for British Railways a.c. motive power—Morgan Crucible

A new development by the company is the use of sintered copper on steel commutator segments, permitting a much stronger and more stable commutator than has hitherto been possible for high-speed traction machines. Sintered bearings, as used in switch and other control gear components, were also displayed.

MICROCELL, LTD.

An example of the electronic supervisors and digital recorders supplied to British Railways for system tests was shown by Microcell, Ltd. The recorders are being installed in electric trains and locomotives and at points along test sections of electrified line, to record such data as the speed and position of trains, the variations in electrical voltage and current consumption under varying load conditions and the general effect throughout the power supply and in other related services. This large programme of data recording and analysis arose out of the many technical problems raised by the 50 c/s electrification programme and in its conception and planning by British Railways and Microcell, Ltd., in collaboration it anticipated similar projects for data transmission and processing in industry.

The Microcell electronic digital recorder (of which an installation is seen in Fig. 15) is in effect an analyser sampling up to twelve different events at the rate of one analogue event every 160 milliseconds. It records such events in digital form in five-unit teleprinter code. A rotary sampling switch feeds the analogue voltages to be recorded into an analogue-to-digital converter, the output of which is in binary code. This information is then fed through an electronic switch via a code converter to five power amplifying valves energising the Creed punch coils. A visual monitor is also provided consisting of a tape-hole sensing unit connected by a code-changing matrix to three dekatron numerical display tubes. An electrically-driven synchronous clock injects the time in hours, minutes and seconds (in binary coded form) into the main information stream. The equipment operates from 50 c/s mains or from batteries and can therefore be installed in moving vehicles or at fixed sites. Vehicle installations are mounted on rubber shock absorbers to reduce vibration effects.

Fig. 15—Electronic digital recorders (left) installed for system tests in a substation of the Eastern Region—Microcell

NALDER BROTHERS AND THOMPSON, LTD.

Numbers of automatic earth proving switches and supply points have been supplied to British Railways workshops by Nalder Brothers and Thompson, Ltd., who demonstrated a switch of this kind controlling four outlets (up to six can be used). Insertion of a faulty appliance or tool into any outlet trips the switch and de-energises any other tools that may be in operation on the same circuit. An operator may test the functioning of the device at any time by withdrawing a tool with the switch on, or by attempting to switch on before inserting the plug. When the switch is closed, a circuit is completed through the primary of a transformer in the device and through a mains voltage trip coil. Under healthy conditions, however, the transformer secondary circulates a small current through two earth conductors, the metal casing of the tool and a current trip coil, causing a relay to open the voltage trip circuit. The relative speeds of operation are such that the breaker will not be tripped unless the earthing circuit is not complete or has a resistance above about 7 ohms.

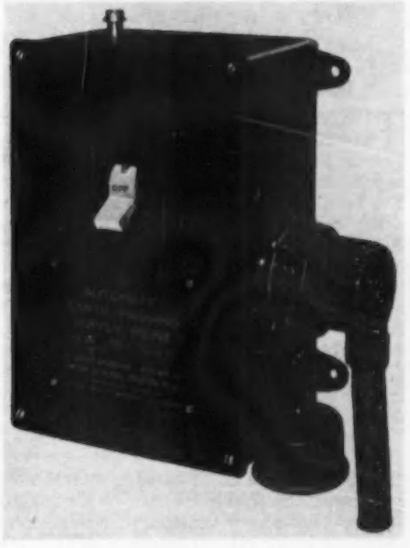


Fig. 16—Earth proving supply point for workshop tools and appliances—Nalder Brothers and Thompson

Drilling Cast Iron

A SERIES of tests is being carried out by the Production Engineering Research Association of Great Britain, to determine the effect of point shape on drill life when drilling various materials. A report just issued by the association deals with the drilling tests on a typical grade of grey cast iron with a view to determining the effect of point angle and relief angle on performance using high-speed drills.

The investigation showed that a marked increase in drill life was obtained when the point angle was decreased from 120 deg. to 60 deg. The best drill life was obtained when the relief angle (measured at the outer corner) was within the range 11 deg. to 15 deg.; a marked decrease in drilling thrust and an increase in drilling torque occurred when the point angle was decreased from 120 deg. to 60 deg. It was also found that relief angle had no marked effects on drilling torque and thrust.

Copies of the report giving full details of the investigation are obtainable from P.E.R.A., Melton Mowbray, Leicestershire, at 7s. 6d.

Electrical Engineering in the Royal Navy

I.E.E. PRESIDENT'S INAUGURAL ADDRESS

In his presidential address to the Institution of Electrical Engineers in London, on October 6, Sir Hamish MacLaren reviewed electrical engineering in the Royal Navy. His address covered developments over more than 100 years, beginning with the installation of an electric telegraph between Whitehall and Plymouth in 1852. He recalled that electricity was first used afloat in the 1870s when simple batteries were used for the firing of guns and that the first use of a dynamo on a warship was to operate a searchlight against torpedo carrying craft, in 1875. Other landmarks included the introduction of the watertight 220V ring main system (H.M.S. "Defence," 1908) and developments such as degaussing, radar and the remote power control of guns in the 1939–45 war. Later developments up to the present day are covered in the following extracts from the President's address.*

Post-War to the Present Day

THE ever-growing demand for electrical power made us realise that the ring-main system, as we knew it, could not cope with any substantial increase in generating capacity. The limit of capacity of individual generators with existing ring-main switchgear was 500kW, and we now needed to think in terms of 1000kW generators at least for future cruisers, aircraft carriers—and indeed even for smaller ships—if we were to keep the number of generators in the system down to acceptable limits. To deal with these larger powers we had to consider the use of a voltage higher than 220V and whether it should be direct or alternating.

The number of motors in ships kept increasing (there are over 1000 in a large carrier), and the replacement of the d.c. motor, with its commutator and brushgear, by the rugged squirrel-cage motor became an obvious and worth-while objective from the point of view of reliability and maintenance.

The position was now different from that in 1932, when a change to alternating current had last been considered and turned down, and with our wartime experience and the larger electrical installations we were able, in 1946, to consider the question on a much broader basis. Furthermore, the ever-increasing demands to accommodate more and more operational equipment in warships made saving in weight and space of paramount importance.

The investigation showed that weight could be saved, even in a relatively small warship with a total of 1000kW of installed generator capacity, by adopting a 440V, 60 c/s, 3 phase a.c. system, with a proportionately greater saving in weight as the size of the electrical installation increased. Such a system had been in use in the U.S. Navy for some time. Although the possibility was considered, a voltage higher than 440V was not selected. With 440V for the basic system a single-phase voltage of 115V was adopted for lighting and small power loads. This voltage was chosen because the lamp filaments would be more resistant to mechanical shock and vibration, the design of miscellaneous small power-consuming devices was made easier, and there would be rather less danger from electric shock from small equipment supplied at that lower voltage.

The choice of frequency was not easy. Theoretically there is a case for adopting a frequency higher than 60 c/s in order to obtain further reduction in the sizes of motors and transformers, but the conclusion was reached that a wholesale departure from available standard designs would be very difficult to justify.

Investigations showed that a motor speed of 1800 r.p.m. would meet a large number of requirements, and this, together with the advantage of 60 c/s in reducing the sizes of generators and transformers, made that frequency very attractive. Naturally, thought was given to adopting the widespread standard frequency of 50 c/s, particularly to make it easy to supply electrical power from ashore ; but the lower speeds would have involved a quite unacceptable weight penalty. So, with the full support of industry when the facts were put before it, 60 c/s was selected. The added advantage of standardisation with the U.S. Navy is obvious, and since we made our decision the other N.A.T.O. navies have followed suit.

Although there is no alternative in cruisers and larger ships because the size of the electrical installation demands a distribution voltage higher than 220V, and therefore preferably an a.c. system, the case for alternating current in the smaller ships rested on :

(*a*) Reduction in weight.

(*b*) Considerable reduction in maintenance effort—an important feature in a small ship in which maintenance facilities are limited.

(*c*) Uniformity of design and operating practice with bigger ships.

An a.c. system is, of course, handicapped by its inability to provide, in a simple way, the speed control of motors which is readily available with direct current. This difficulty has been overcome to some extent by persuading the designer of the driven machinery that several speeds are not essential or, at the most, that a choice of two—obtained by pole changing—would meet his needs. For certain equipment, of course, a range of control of speed is essential and the extra weight and complexity have to be accepted.

The investigations which led to the adoption of alternating current in warships of destroyer size and above were made in connection with the design of a new class of cruiser and the "Daring" class destroyers. No orders were placed for that class of cruiser, but eight "Daring" class destroyers were ordered, and approval was obtained to build four with d.c. systems and four with a.c. systems so that a direct comparison could be made in ships where the advantages of a change to alternating current were marginal. It was intended to await operating experience with these ships before finally considering a wholesale change to alternating current ; but before such experience was available it became necessary to design systems for three new types of frigates, and it was decided in 1948 to adopt alternating current for these and all future ships larger than minesweepers. Special considerations apply to minesweepers which favour the continued use of direct current.

The first large ships to have an a.c. system were the "Tiger" class cruisers, the construction of which had been suspended at the end of hositilities, because when it was eventually decided to complete these ships with modern armament and radar the consequent large increase in demand for electrical power had to be met by substituting four 1000kW a.c. generators for four 500kW d.c. generators.

The recently completed aircraft carrier H.M.S. "Hermes", was dealt with in a similar way. Within the limits imposed by a design not originally intended to accommodate a large a.c. system, the generators and their switchboards are grouped as units close to their associated boiler-rooms.

When working out the details of the new a.c. systems it was necessary to lay down voltage regulation standards. It was decided to adopt a system in which the generator voltage is controlled to fine limits by using rapid-response automatic voltage regulators in association with appropriate exciters, and a cable system designed to give the minimum practicable voltage drop. Thus designers of individual items of equipment would have the benefit of a closely controlled supply. The alternative which was rejected was to control the generator voltage by more conventional methods giving a wider range of voltage regulation, and at the same time to allow a wider range of voltage drop in cables. This would have meant that, where necessary, the designers of certain equipment would have had to incorporate voltage-stabilising equipment in their apparatus to provide the closer voltage limits.

It was decided that the voltage at the generator terminals should be maintained within the limits of ± 1 per cent, and that the largest voltage drop allowed on the system due to starting induction motors should not exceed 15 per cent. Furthermore, after this voltage drop, recovery to ± 1 per cent was designed to be achieved within 0·3 second. Later, it was found that a recovery time of 0·5 second was acceptable. Frequency standards were also laid down.

Some converted supplies at higher frequencies are inevitable in a warship, but every effort is made to keep the amount of conversion equipment to a minimum. The higher frequencies selected are 400 c/s and 2400 c/s. These are nominal and are derived almost entirely from generators driven by induction motors which produce a near multiple of 60 c/s. Direct current is still required for such services as degaussing, field excitation for special motors, computing and telephones. These supplies were largely provided by motor-generators in the first a.c. ships. Selenium rectifiers were also used and are still in use. They in turn are being superseded by silicon rectifiers, where appropriate, with a significant saving in weight and wild heat.

The 440V 3-phase system is a three-wire insulated system with no earthed neutral. This differs from shore practice, but the essential feature in a warship power system is to maintain supplies in an emergency, and it is thus necessary to avoid tripping of circuit breakers as a result of an earth fault on one line. Earth faults are indicated on the switchboard and are dealt with by the maintenance staff as soon as possible. The aspect of shock to personnel was not lost sight of when the all-insulated system was adopted. With alternating current a voltage over 50V can be

* Director of Electrical Engineering, Admiralty.

fatal, and although by introducing an earthed neutral the possible voltage to earth is reduced, even this reduced voltage of 260V is highly dangerous in a ship. All 440V equipment is therefore designed to prevent accidental contact with live metal and is provided with " difficult access " covers. The main switchboards are totally enclosed with dead fronts, and the breaker and switch-fuse units are withdrawable for servicing. It is very reassuring that so far we have had a casualty-free record.

Portable equipment is supplied from 115V single-phase systems which are unearthed. In order to increase the safety of such equipment, the circuits are taken from small transformers (not greater than 5kVA) reserved for such use, or from reserved separate phases of larger transformers which have open-delta secondary windings. The ship's lighting and miscellaneous small-power equipment have their own transformers, so that the possibility of earth faults on the portable equipment socket networks is reduced to a minimum. A 50V supply from special transformers is provided for boiler-cleaning equipment because of the enhanced risk of shock when performing this work.

It may be of interest to remark on a few of the special design problems which arose and which continue to demand our attention as a result of the use of alternating current.

The design of the circuit breakers and motor control-gear for the first a.c. ships called for the closest collaboration between the Admiralty and industry because of the difficulty in making equipment of this type proof against shock from underwater explosions. For motor control-gear the problem could have been eased by using d.c. operation from rectifiers ; but the aim was to save weight and space wherever possible and to provide simple, easily maintained equipment. Few firms were able to meet requirements when the first a.c. ships were being built, but that position has now been rectified and we can call on many more firms for this specialised equipment.

Single-speed squirrel-cage motors with direct-on-line starters are used wherever possible. In the first ships a few reduced-voltage starters were necessary, but the later ships have larger generators and direct-on-line starters can be used in all instances. A few of the larger motors are designed for low starting currents, thus avoiding the necessity for complicating and adding weight to the control gear with voltage-reducing devices.

The method of obtaining over-current discrimination with the d.c. breakers in the ring-main systems was a well-tried one, and the same method was adopted for the hand-operated electrically-retained, and the electrically-operated, circuit-breakers in all a.c. ships to date, by using d.c. solenoids supplied from rectifiers. Short-circuit trials carried out in H.M.S. " Diamond," one of the " Daring " class destroyers, showed that the system was not ideal for a.c. ships, and improvements have been incorporated in new designs of circuit breakers for later ships to ensure more reliable discrimination and better protection of prime movers against severe overloads.

The introduction of alternating current brought with it the problems of voltage regulation of generators. With the relatively stable d.c. generator, push-button control of voltage by the switchboard attendant was acceptable, and in the d.c. era radar and other equipment requiring close-voltage a.c. supplies were catered for by motor-generators with carbon-pile voltage regulators. With a.c. generators some degree of automatic voltage control was accepted as being essential, and, that being so, it was decided to adopt a system of automatic voltage regulation which would meet the requirements of all basic-frequency equipment in the ship. The first a.c. ships used a thermionic voltage regulator which was duplicated, with means of automatic changeover from one channel to the other. The output was used to energise the control winding of a cross-field exciter. This system gave a voltage regulation of better than 1 per cent with a recovery period of twelve cycles following the throwing-on of the test load of half full-load current at a low power factor.

The accelerated building programme in the early 1950s resulted in several generators of different outputs and several new designs of voltage regulators having to be put into service before experience with the earlier type of regulators had been gained. One of the designs incorporated a magnetic amplifier and this has given good service. In 1957 representatives from industry and from the Admiralty collaborated in the development of a standard design of automatic voltage regulator employing a single-channel magnetic amplifier. Power for the amplifiers is taken from an auxiliary 1600 c/s permanent-magnet generator, which ensures continuous operation during the recovery period following a severe short-circuit. These regulators can be used with single exciters of conventional design to cover a range of generators from 150kW to 1500kW.

Warship electrical systems are designed with a view to maintaining electrical supplies even though damage occurs in action. In spite of this, war experience proved the value of a system of emergency cables and connectors which can be used when damage to the permanent wiring is extensive. The problem of designing an emergency cable system for use at 440V a.c. under the conditions likely to prevail after severe action damage was no easy one. It has been solved by using plug-in connectors on the ends of the flexible cables, the connectors being fitted with safety sleeves which retract when the plus is inserted in the appropriate socket. The plugs can be inserted only in the correct phase socket, and are locked by an insulated key. Provision is made for emergency supplies to be taken from the switchboards by means of a special type of socket on the switchboard, and arrangements are made so that important equipment can be given an emergency supply through sockets adjacent to the motor starters or in the fuse panels supplying groups of equipment. It is necessary, of course, to provide special watertight bulkhead terminals so that the emergency power can be taken through the ship without having to leave watertight doors open. Coils of prepared cable, fitted with the protected plugs (Fig. 1), are dispersed throughout the ship. Portable fuse panels and transformers for lighting are also provided.

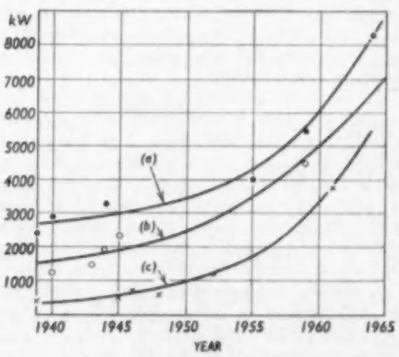
Fig. 1—Emergency cables

There is no doubt that the decision to adopt alternating current was right. Admittedly, many problems have arisen and not all have been completely solved. Motor reliability is not yet all it should be, but new insulating materials will help us towards our objective of greater reliability.

Before concluding this review of post-war progress, it seems appropriate to make some reference to the selection of prime movers for driving generators. In this aspect of warship design, as in many others, the requirements of peace and war are conflicting. In peace it is necessary to reduce watch-keeping in harbour to a minimum so that it is desirable to let steam die down and change over from steam turbo-generators to diesel-generators. Thus the peacetime role of the diesel-generator is to maintain supply in harbour.

In war it is normally necessary to keep up steam even in harbour, which means that the steam turbo-generators can continue in use. The function of the diesel-generators then becomes that of providing a standby or auxiliary source capable of providing sufficient power, in the event of all steam being lost, to supply the salvage load, with enough left over for at least the anti-aircraft armament so that the crippled ship may still defend herself. These separate functions are not always compatible, and as in other aspects of warship design the best compromise has to be reached. The gas turbine is capable of fulfilling a dual role, and with that in view some of the generators in our latest ships—the guided-missile destroyers and the general-purpose frigate—are driven by gas turbines.

The demand for electrical power in warships has increased by leaps and bounds. Fig. 2



(a) Aircraft carriers ; (b) Cruisers ; (c) Destroyers.

Fig. 2—Growth of generator capacity

shows the growth of generating capacity in various types of ships over a number of years. Part of the increase in later years is admittedly due to a greater acceptance by all concerned of the need for more reserve than was usual before the war. Apart from the obvious growth in the use of electricity for motor-driven auxiliaries, particularly since the advent of alternating current, there has been a steady increase in the operation power demanded for weapon systems, radar and radiocommunication. The domestic electrical load continues to grow, ranging from air conditioning to drinking-water coolers. The modern sailor expects reasonable amenities and to be able to use his own radio set, record player and electric shaver.

In aircraft carriers there is a heavy demand

for electrical power at various voltages and frequencies in the aircraft hangar and on the flight deck for servicing aircraft. Also the electrical equipment associated with airborne radar and missiles requires to be energised for long periods whilst awaiting take-off to avoid unnecessary running of the aircraft's engines.

In this post-war section I must make some reference to other improvements and progress in various aspects of naval electrical engineering. A much higher standard of demagnetisation is now necessary in minesweepers to ensure safety when sweeping in shallow waters. Even the eddy currents induced in the metal frames of composite wood and aluminium hulls when rolling in the earth's magnetic field are capable of producing fields which can fire a sensitive magnetic mine. These unwanted eddy-current fields have to be compensated. Detector coils, fitted at the top of the mast, provide signals which, suitably amplified, initiate compensating currents in the ship's degaussing coils.

The development of the electrical analogue computing systems for modern anti-aircraft gunnery is an outstanding example of post-war naval electrical engineering. A distant aircraft target is detected and held in the sights of a director or its modern equivalent, a tracking radar set. The movements in elevation and training of the director or radar as it follows the moving target provide data from which the present position, speed and direction of the target can be computed. Solving further equations will predict its future position, and equating these to yet further predictions of where a shell will be at a given time after it is fired will yield, if the calculations are correct and completed in time, the necessary information as to where to point the gun so that the shell and the target will meet. It is also necessary, of course, to make accurate allowance for other factors, such as the rolling and pitching of the ship. A solution to this problem was reached by developing electrical analogue computers capable of continuous computation and prediction. This was a long and complicated task, but it was successfully accomplished and has resulted in gunnery accuracies hitherto unattainable.

To facilitate production and maintenance of such a system, it was divided into sections and further subdivided into a large number of individual plug-in units. Although a comparatively large number of amplifiers were required, it was found possible to confine them to a few basic types, which were arranged to conform to common dimensions, so that all would plug into a common rack.

Internal communications play a vital part in the running of a warship. They range from straightforward 500-line automatic telephone exchanges of the G.P.O. type used for administrative purposes, and installations for entertainment, to a series of operational communication systems. The most complex of all permits aural communication in an ambient noise level of 130dB. The most obvious example of the need for this system is the flight deck of a carrier when the aircraft jet engines are running. The problem was solved by radiating signals from a loop round the flight deck. These are picked up by a miniature transistorised personal receiver, the output of which is fed to a telephone-type inset in the earpiece of a noise-excluding headset worn by all personnel concerned.

The scale of an internal communications installation in a modern aircraft carrier may be gauged from the fact that there are over 800 telephones and well over 600 loudspeakers. An experimental closed-loop television installation has recently been completed for the briefing of air crews.

Since 1945 a major contribution to saving in weight has been made in cables by replacing the lead-alloy sheathing with a polychloroprene sheath—30 tons weight were saved in a destroyer of the " Daring " class. The removal of the metallic screening, however, raised doubts whether the interference with W/T reception would be unacceptably increased. Careful attention to suppression of interference at its source, and the use of " in line " capacitors as filters, has avoided any increase in radio interference.

A more recent change resulting in a further saving in weight has been the introduction of silicone rubber as the insulant for all cables. This change was made possible by the co-operation of the British and American cable manufacturers after a detailed examination of American practice in this field. One of the advantages is that the residual ash of silicone rubber, after being subject to fire, continues to act as an insulant so that circuits continue to function even after compartments through which the cables are run have suffered damage by fire. The combination of polychloroprene sheathing and silicone-rubber insulant has made possible cables of reduced diameter and weight so that installation is greatly facilitated. The saving in weight and in the space occupied by cables is also valuable. The value of the change is well illustrated by Fig. 3.

Fig. 3—Cable trunk

I shall complete this post-war section with a brief survey of the special electrical problems associated with the submarine.

The war was fought with submarines in which, although there had been detailed improvements, the electrical systems by which the vessels were propelled when submerged were substantially as they had been for twenty years. The main battery, in two or three sections each of 112 lead-acid cells, gave a nominal voltage of 220V, and was only sufficient to permit maximum submerged speeds of 9 knots for periods of less than one hour. Speeds to permit reasonable submerged endurance had to be as low as 4 knots. The circulating air in the main motors was water cooled, and switchgear comprised open-type hand-operated knife switches protected by fuses. The limitation on submerged speed and endurance was a very serious handicap to submarine operations, and after the war great efforts were made to improve the underwater performance of new designs.

The first attempt made use of the Walther system, in which oxygen is stored in the form of highly concentrated hydrogen peroxide (high test peroxide) and used as the oxidant for burning oil when submerged. Two experimental submarines with this system are now in service, and until 1959 held the world record for underwater speed. The machinery, however, is complex and requires much maintenance. H.T.P. is a very dangerous and expensive liquid, and high speed endurance is limited to a few hours by the amount of H.T.P. which can be carried.

The second method of improving submerged performance is by increasing the capacity of the battery. Wartime built submarines of the " T " class were cut in two and lengthened.

The " T " conversion, as it was called, was a stop-gap, and in the new " Porpoise " class a radical departure from previous design practice was made. There is one twin-armature main motor on each shaft, and these are used to propel the vessel on the surface as well as submerged. The whole power of the ship is controlled from one position, and this was an innovation in submarine electrical engineering practice.

For maximum speeds the batteries are connected all four in series to give 880V, and for ordinary working the system voltage is 440V. Motor-driven cam-contactor switchgear is used, and special attention has had to be given to fault protection by means of high-speed high-breaking-capacity switchgear. To test the equipment, one of the largest-capacity d.c. short-circuit-testing installations in Europe was built at the Admiralty Engineering Laboratory. For transmission of power through the boats between batteries, main generators and main motors, copper busbars insulated with moulded micanite and metal-enclosed are used.

In electrically propelled submarines the battery determines the limits of performance, and by careful attention to design, thinner plates and improved separation, the capacity of the standard lead-acid cell has been increased from 4750Ah, at the five-hour discharge rate, at the beginning of the war, to 6560Ah at the present time. Despite this increase in capacity an operational life of 300 cycles is still obtained.

There are, however, other problems for the battery designer besides specific ampere-hour capacity. Hydrogen gas is constantly being evolved from lead-acid batteries and a mixture of 4 per cent of hydrogen with air is highly explosive. It has been found possible to reduce the open-circuit evolution of hydrogen by the development of battery grid alloys with low antimony content. Research is continuing in an attempt to produce batteries completely free from antimony which will not evolve any hydrogen at all on open-circuit, and at the same time will eliminate the production of antimony trihydrite (stibine), a very toxic gas.

Water cooling has been adopted for the latest high performance batteries, and a further development is electrolyte agitation to permit shorter charging times.

Battery containers have been continuously improved to withstand shock resulting from depth charges. Ebonite containers were first superseded by laminated plywood with a rubber lining, and these in turn have been replaced by rubber-lined resin-bonded glass-fibre boxes.

The latest method of improving submarine performance is the introduction of nuclear propulsion plant which, by providing virtually unlimited power and endurance, will revolutionise submarine warfare. Indeed the

submarine becomes at last a true submarine and not just a submersible vessel. Although there are many special problems, the electrical installation in a nuclear submarine in fact becomes more like that of a modern surface warship with the addition of an electric drive of small power for emergency use. Also, a nuclear submarine must still have a battery for starting up and emergency standby, although this is reduced to one section of 112 standard submarine cells. Because of the possibility of prolonged submerged operation the problem of hydrogen evolution assumes even greater importance than hitherto, and a further complication is introduced by the danger of accumulating stibine. The efforts to develop a reliable battery with antimony-free plates have therefore been increased.

Like surface ships the submarine has to accommodate an increasing amount of electronic and servo equipment for weapons, asdic, and other purposes ; and to this is being added, in the atomic submarine, new problems of reactor control and instrumentation. Space for all this equipment is difficult to find, but in the application of the semi-conductor in its various forms lies hope for some easing of problems of space, reliability and performance.

The Future

I propose to conclude my review by very briefly attempting to forecast what further changes we may see, perhaps in my lifetime.

In the personnel field, I think it will be inevitable that the pattern of increasing specialisation in design of equipment and installations must continue to an even greater degree.

In the materials field, thanks to the close co-operation that exists between the Admiralty and the electrical industry, knowledge of new discoveries and developments becomes available at a very early stage so that possible naval applications can be kept in mind. Constant application of judgment will be increasingly necessary to decide when new materials and devices can be adopted for warship installations. The biggest drive in future years will continue to be for increased reliability and reduction in size and weight in every field of application. Already in the electronics field this has led to micro-miniaturisation and the adoption of semi-conductors for many applications. In the ever-broadening sphere of the semi-conductor, possibilities range from microamperes to kiloamperes, embracing minute amplifiers and bulk power conversion.

Generation of power at frequencies higher than 60 c/s and voltages above 440V may be found necessary. Production of power by such methods as the fuel cell and thermo-electric generators may become practicable in the not too distant future, though much development work still remains to be done.

Nuclear propulsion of submarines has already been proved ; but if it can be justified for surface warships it will present problems which have still to be tackled. The electrical engineer will be involved in the development of faultless and foolproof control systems, and in novel designs of auxiliary electrical machinery, capable of working continuously under very adverse conditions without risk of breakdown.

These and similar problems which are associated with missile installations will keep my successors in the naval electrical engineering field fully occupied, and will exercise not only their ingenuity, but also that of their colleagues in industry and elsewhere, whose enthusiastic co-operation will be just as essential in the future as it has been fruitful in the past.

First Machine Tool Design and Research Conference

By HUGH CLAUSEN

Mr. Hugh Clausen's vigorous criticisms, both of the British machine tool industry itself, and of those scientific and educational bodies which might have (but did not) come to the help of the industry in developing a logical approach to the art of engineering design have already appeared in our columns.[1] He now returns to the charge by giving his impressions of the five-day Conference on Machine Tool Design and Research at Birmingham University.

IN 1794 the Rev. William Farish (1759–1837), Fellow of Magdalene and Professor of Chemistry, started a course of lectures at Cambridge on " The Application of Natural Philosophy, Natural History, Chemistry, &c., to the Arts, Manufactures and Agriculture of Britain."[2] He later illustrated his lectures with a cleverly devised set of model elements by which different mechanical problems could be demonstrated, apparently somewhat on " Meccano " lines. This course continued for many years, and set the tune for a kind of dilettanti amateurism which has bedevilled the teaching of engineering subjects ever since in British universities.

Cambridge—in point of fact—only appears to deal with " The Mechanical Sciences," which may, or may not, provide a good foundation for engineering—depending on the character and previous experience of the man concerned.

In 1869 Joseph Whitworth (1803–87), who had worked as a skilled mechanic in the shops of Henry Maudslay, and had shown a real genius for engineering design and craftsmanship, especially in metrology and machine tool work, founded, and provided with the necessary funds, his well-known Scholarships and Exhibitions.[3] A limited number of young men of promise in the field of engineering were thereby enabled to obtain a better technical and general education and widen their outlook.

The conditions for these were—not unnaturally—based on his own personal experience, in which an instinctive feeling for materials, and for learning through the fingers as well as through the head, played a dominant part. His outlook was, in fact, real ENGINEERING. His Baronetcy was awarded to him in the same year as that in which the Scholarships were founded.

As far as I know, no industrial leader (until the last year or so) followed his example of practical help in balancing the science and the art of engineering ; and in the years that followed, the watch-making industry, for example, in which we led the world in 1860, dwindled to nothing. This appears to have been due to a lack of interest, in both the scientific and industrial worlds, in the problems involved in the design and manufacture of the machine tools required to make the components ; and in the development of the modern type of craftsmanship.

All this is preliminary to the Machine Tool Design and Research Conference, of which my strongest impression is that the two groups of men—those from the industry and those with research or academic backgrounds — hardly spoke the same language.

So wide has become the phase angle between the science and the art that any discussion between the two carries a large wattless component which, though it may generate considerable heat losses has given rise—up to the present—to little effective work output.

A very unfortunate factor was that no papers were given by representatives of the industry. Two papers from a young industrial research establishment were not at all typical of industry. There may be many reasons for the absence of such papers ; but the resulting lack of appreciation of what the problems of industry really were, left the meeting to end on an unresolved chord.

It is quite clear that there is no essential difference between machine tool work and any other form of mechanical engineering. The higher degree of precision needed in manufacture, and the higher quality of thought needed for design, are differences in degree rather than in kind.

It became quite clear almost at the outset that the two major matters, the science and theory of metal cutting, and the art of machine tool design, had never coalesced, in spite of the work of Farish and Whitworth. The reason seems to lie in the fact that the early Victorian technical schools and polytechnics rarely, if ever, reached an adequate level of thought or esteem ; whilst the contemporary Continental and American foundations soon reached a university level.

Papers dealing with the application of servo controls to machine tools, largely on a servo theory basis, fell rather flat. It seemed that perhaps a majority of the experienced men in the audience simply had no idea of what the lecturer was talking about. One of my industrial friends—referring to this as a waste of time when more important questions were still unsolved —remarked with some truth that servo controls only affected about 1 per cent of the industry anyway.

Another very significant impression was that, with exceptions, the more outstanding papers were given by men with Continental engineering backgrounds. The most striking paper of all, which brought roars of applause from engineers and scientists alike, was by Professor Eisele, of the Technische Hochschule, Munich.

I have no doubt whatever as to the potential value of the conference ; particularly if it is repeated at suitable intervals. It was apparently the first time that the scientists and the machine tool engineers had come together : to demonstrate their different attitudes of mind, and to show to the engineering world how few there are who have an effective foot in both camps.

Whether this potential value will be realised—and when—depends on a mature understanding by both sides of the very serious national consequences of this wide phase angle between the science and the art. A nation with an alert, vigorous, and forward-thinking machine tool industry has the finest possible human and material foundation for the rapid and effective development of all the industrial arts, whether of peace or war. The nation without is dangerously dependent on others.

References

[1] The Engineer, March 11, 1958, Letter to the Editor.
[2] *THE CAMBRIDGE REVIEW*, February 20, 1960
[3] *THE WHITWORTH BOOK* (History of the Whitworth Scholarships).

Motorways: Some Constructional Problems

Last Friday a paper was presented at the Institution of Highway Engineers entitled "Lessons Learned on the Design and Construction of Motorways (i) From the County Surveyors Angle," by Mr. H. Bowdler, M.I.C.E., the county surveyor of Kent. Mr. Bowdler reviewed the whole field, but here we reproduce from his paper his views on two topics only, viz. the delay in getting work started, and the subsequent call for fast construction. This abstract is probably the most highly critical section of Mr. Bowdler's paper.

THE delay in starting road work is so often said to be due to the procedure for protection of the rights of the citizen, but I do not agree that this is the sole factor or even the main factor. After all, the objection period for a draft order is only three months and since some of the objections will come in well before the end of the period it should not take very long after this to prepare for a public inquiry to resolve these matters.

This is the full procedure for the consideration of private objections and it might be thought that things would now move quickly, but if the finding at the inquiry has been somewhat controversial, further delay before any move is made towards confirming the order in any form has sometimes been very great. This is quite incomprehensible since all the information has by then been collected and all that remains is the taking of an over-riding decision. One carries on with detailing during this time but obviously the impetus is not very great without the knowledge that the scheme is to proceed as designed. Again, the legal requirements of land acquisition have been blamed for the delay, but I think that once the district valuer has received his authority to negotiate, entry on to the necessary land can be obtained quickly in most cases though the completion of the full legal formalities may be very much slower.

No, I am really convinced that the difficulty has lain in the forward planning of these schemes, or rather the lack of it, on a countrywide basis. It is only because initial investigation of new schemes by agent authorities was not authorised years ago (when engineers already realised their necessity although obviously financial stringency would delay construction for some years), that there is such a drive to get the work prepared hurriedly now. When, a while ago, the Minister said that he might even have to call in Continental engineers to get the jobs done quickly enough, one felt tempted to say that the import of some of the Continental administrators who seem to have accepted the advice of their engineers on road problems some years ago, might have had a more stimulating effect when it was most needed.

Early investigation of schemes would have built up a nucleus of experienced staff during the early post-war years and scheme preparation would have proceeded smoothly from this. As it is, the rapid development work called for requires the taking on of temporary staff or a lot of overtime working by existing staff, and I feel must preclude to an extent that thorough investigation and calculation of alternative solutions to the many problems encountered, which is desirable for the choosing of the best and most economical solutions. It is rightly said that we are learning rapidly by experience about these new roads, but I do feel that some of the lessons could have been learned before they were translated into stone and concrete if planning had started earlier. This situation still applies in that preparatory work is often not started on a new road project until a date can be set for its construction. More authorisation by the Ministry of long-term planning of and investigation into new roads which are thought to be necessary but whose construction date is well into the future would, I am sure, pay dividends of economy and efficiency.

The uncertainty of forward planning has not been lessened by the Minister's recently announced policy towards appointing consulting engineers for motorway projects. Much work done by highway authorities in the past may be rendered valueless to them by this, and it is no encouragement for them to spend time and money on investigation of future motorway projects. It seems somewhat ironical that shortly after the Ministry starts on a motorway plan which is very like that formulated by county surveyors twenty-five years ago, the Minister decides that the county surveyors of to-day are not really the right men to implement it, this in spite of the work already done. For instance, in Wiltshire as long ago as 1950 when a halt was called 21 miles of the London–South Wales Motorway had been prepared up to the order stage and 7 miles up to the contract stage. The adjoining counties had done similar work. Of course, changes in thought have taken place since that time and some of the designs would need to be brought up to date.

The proposed 35 mile motorway between Leeds and Sheffield has involved many hours of work in planning the route, surveying the property affected, and in preliminary designs for over seventy bridges, besides investigating the alterations to some 175 services of statutory undertakers. The route, which passes through sixteen local authorities' areas, many of which are built-up, has needed to be very carefully selected and a detailed knowledge of the site has been acquired by those carrying out this work. It seems illogical that those who have carried out this spade work should be denied the opportunity of carrying the scheme to completion.

Contracts

The current fashion is for "two summer" contracts of nineteen months. The main reason for this would appear to be political, for although no County Surveyor would question the urgency of building more motorways, we have waited for so long that a further few months on the completion of a scheme would make little difference, especially if schemes could follow one another more closely. If a contractor were not committed to the hilt by a tight contract period he could bid for another project in the knowledge that his labour and plant could progress from one site to the next. The total national expenditure on new roads could be just as great but each project would not be so influenced by the weather conditions. The Committee on Public Accounts has just had something to say about estimates, admittedly preliminary ones in the main. It is difficult to predict the final cost of a contract even after seeing the tender sum when progress is so tied to the two traditional "summer" periods. A really bad summer can render most expensive counter measures necessary if several million-pounds-worth of work is required to be done by the end of the next summer and I wonder whether tearing through big-scale earthworks, no matter what the state of the soil which is being compacted, is really an economic business.

It is thought that we shall have to accept the fast timetable as a feature of modern road making and adapt ourselves to it. From the designer's point of view this entails providing in the specification for alternative methods of construction which may be resorted to when conditions demand it. This may entail changing the base or sub-base construction or perhaps providing for the running to spoil of excavated material susceptible to wet conditions and its replacement by better soil. The basis of these provisions is that on a modern contract there must be plant moving on the job the whole time and if the movement is prevented or does damage to permanent work the job will suffer.

The other brake on the smooth progress of road making plant is, of course, bridges. It seems very desirable to make an early start on construction of bridges, and I wonder whether past practice of letting road and bridge works as one contract is the best. Bridges are often linked with alterations to services which possibly cannot be done quickly if supplies are to be maintained. If earth moving has started at the same time as the bridgeworks a lot of expensive temporary bridging is often necessary to keep the plant moving during these unavoidable delays in bridge building. Otherwise, some part of the earthwork has to be left to carry the temporary road until the bridge is through. In the case of an overbridge the motorway will usually be in cutting and the bridge will rarely be at the crest of a hill so that there must be a downward gradient towards the bridge site on one side. The contractor is tempted to chance the weather and get as much earth moved as early as he can. If he does so and is unlucky with the weather, everyone is faced with an appalling mess all round the bridge which is a nuisance for a long time, and the engineer is faced with condemning a lot of earth which has been perfectly good fill before the temporary "dam" has formed a lake over it, and authorising the buying of fill from outside.

Self-Adhesive Packaging Material

A NEW packaging material called self-adhesive "Carbion", developed by Spicers, Ltd., Loughton, Essex, consists of a strawpaper or similar base with a permanent double-wave "dimpled" pattern. This pattern flattens under load but regains its shape when the load is removed, making the material resilient and giving it considerable cushioning properties. The material is coated on one side with adhesive latex solution so that when it is folded back on itself the touching sides form a bond which, while firm, can be parted by pulling the sides apart.

Parts to be protected are simply placed on a piece of the self-adhesive "Carbion" of appropriate size, which is then folded back on to itself and pressed down along the edges.

[Reply Card No. E6302]

LETTERS AND LITERATURE

Letter to the Editor

ROAD ACCIDENTS

SIR,—The summary of the lecture by Mr. L. E. Flory which is printed on pages 175-176 of THE ENGINEER for July 29 contains a sentence which goes right to the heart of the situation described in the *Statistical Analysis of Road Accidents in* 1959, *Metropolitan Police District*, issued on July 29. According to Mr. Flory, " the least reliable element " in the system of protection which he describes " is the human link which must receive the information, make a decision, and institute action, often within a fraction of a second. " No doubt it is this element which goes far to account for the 71,956 road casualties resulting from 58,150 accidents (an increase of 5572 accidents over 1958), the analysis showing how almost nine people in every thousand of London's population were injured in road accidents last year, with more than one in every thousand seriously injured. The feature which seems most portentous lies in the steep rise, since 1957, of the curve showing the number of persons *killed* in road accidents. One inescapable conclusion drawn from the figures is the urgent need for expediting those road works which cannot fail to render road traffic less lethal notwithstanding the weakness in the human link which has been referred to by Mr. Flory. The extent of this weakness and of the increasing peril thereby involved is brought home most vividly by pondering what is one of the outstanding differences between rail traffic and road traffic : The immense disparity between the number of drivers required, in road traffic and rail traffic respectively, for transporting large numbers of people. If, for example, we take a look at Bank Holiday traffic passing through the Clayton tunnel of the Southern Region of British Railways, we will note that the twelve-coach electric trains conveying up to say 900 passengers are controlled by a single driver who has the precious assistance of a variety of safety devices, to say nothing of the colour signalling and his intensive experience of the line. It so happens that immediately adjacent to the north portal of the Clayton tunnel lies the road along which flows the heavy motor traffic between London and Brighton, the stream including private cars, lorries, motor-cycles, motor-cycle combinations, scooters, pedal cycles and now and then a caravan towed by a light car and followed by a frustrated aggregate of vehicles unable to overtake with safety. To move 900 people by so heterogeneous a collection of road units and assuming that (including cyclists) the average number of persons per vehicle is three, not one driver but 300 drivers are required, each exercising unfettered control both of speed and of lateral movements. It is upon this mass of drivers, comprising both sexes, all ages and endowed with the normal range of mental, temperamental and physical qualities, that the safety of the multitude—motorists and pedestrians alike—depends. Here lies a fundamental difference between intensive traffic as handled on the railway and the road respectively, since the " human link " referred to by Mr. Flory must " Make a decision and institute action, often within a fraction of a second. " This was doubtless the link which Pope had in mind when he wrote the couplet :

" 'Tis with our judgements as our watches, none
Go just alike, yet each believes his own."

Human nature does not change and we may be sure that there were Egyptian chariot drivers who made roads dangerous in the time of the Pharaohs. What changes are the tools, not the men, and while there has been a stupendous increase in the weight and speed of traffic, the laws of motion remain constant. The risks when driving over inadequate roads become greater not only with the number of drivers but with the weight, speed and type of the vehicles which they control. To lessen these risks and provide for inevitable increase in traffic, we need to have high average standards of skill and caution in driving and roads which are so dimensioned, planned and equipped as to afford, when crowded, the safest possible path. We need also to keep in mind, when examining accident statistics, the influence of the pedestrian. The *Statistical Analysis* referred to above shows how in adult and child pedestrian accidents during 1959 nearly a quarter of the adult casualties and 1635 of the child casualties were due to starting to cross the road when masked, by stationary vehicles, from the view of oncoming traffic.

" CALLIPIDES "

London, S.W.7,
September 15, 1960.

Book Reviews

Thermochemistry for Steelmaking. Vol. I. By JOHN F. ELLIOTT and MOLLY GLEISER. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 75s.

THIS volume, prepared in the Department of Metallurgy of the Massachusetts Institute of Technology, is the first of a series planned by the Department. A vast amount of physico-chemical data on materials and systems of importance in iron and steel-making is available in published form, but it is widely scattered and often in diverse forms. For the past four years the department has been working on a programme, sponsored by the American Iron and Steel Institute, to collate and summarise in one source the data available. This volume is the first step in the programme, which is concerned with the high-temperature chemistry of iron and of all the other compounds related to it by the present and future chemistry and technology of steelmaking.

In the present volume the authors have concentrated on presenting information on the pertinent chemical properties and some physical properties of important elements and compounds. The data it contains will be used as a foundation on which to develop material to be included in subsequent volumes ; these will be published as time and funds allow. A large mass of material has already been collected ready for use in the future volumes.

The present volume is arranged in four sections, dealing in turn with the physical properties of selected elements, thermochemical properties of selected elements, standard heats and free energies of formation of selected compounds, and vapour pressures of selected elements and compounds. No data are included on the enthalpy increments, entropy increments and heat capacities of pertinent compounds because a new publication on these matters by Dr. K. K. Kelley, of the U.S. Bureau of Mines, is in the final stages of preparation.

Stufenlos verstellbare mechanische Getriebe. By F. W. SIMONIS. Second enlarged edition. Berlin-Göttingen-Heidelberg : Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3. Price DM.29·40.

IN many engineering applications—one thinks immediately of the paper industry, printing, textiles, and many kinds of machine tools—a variable speed drive is of great importance to the optimal functioning of the designs concerned. Since the present book made its first appearance in 1949, the subject has grown in volume to such an extent that it has become necessary to confine the new edition to mechanical transmissions. The principal types, which are covered in detail, include friction drives using cones, cylinders, rotating rings, and spherical transmission elements, others incorporate rotating balls or rollers. A further main section deals with variable-speed belt and chain drives. Other designs described are those which transform the uniform rotation of the input shaft into an oscillating motion of an intermediate shaft which is then mechanically " rectified " to give a more or less uniform rotation of the output shaft. Among the theoretical aspects considered are the automatic speed control throughout a given cycle.

Books Received

Railway Works Construction. By H. M. Pearson. Odhams Press, Ltd., 96, Long Acre, London, W.C.2. Price 35s.

Who's Who in the Motor Industry. Fourth Edition, Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 42s.

The Development of the English Traction Engine. By Ronald H. Clark. Goose and Son, Ltd., Davey Place, Norwich. Price 84s.

Introduction to the Gas Turbine. By D. G. Shepherd. Constable and Co., Ltd., 10, Orange Street, London, W.C.2. Price 45s.

Heat Transfer Engineering. By Hilbert Schenck. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 28s.

Coke-Burning Appliances Handbook. Sixth edition. The Gas Council, Murdoch House, 1, Grosvenor Place, London, S.W.1. Price 35s.

Mechanical Engineering Craft Practice. By H. C. Town. Chatto and Windus, Ltd., 40-42, William IV Street, London, W.C.2. Price 16s.

A Century of Traction Engines. By W. J. Hughes. Percival Marshall and Co., Ltd., 19-20, Noel Street, London, W.1. Price 30s.

Workshop Engineering Practice. Vol. 1. By H. G. Rider. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 9s. 6d.

Road Surfaces, Seeing and Driving

No. II—RECENT STUDIES IN VISIBILITY AND ACCIDENTS

BY J. M. WALDRAM, B.Sc., A.M.I.E.E., F.I.E.S.*

(*Concluded from page 596, October 7*)

In a paper presented to the Association of Public Lighting Engineers at Folkestone on September 15, Mr. Waldram discussed some recent studies on road surfaces and their effect on seeing and driving. The first part of the paper reviewed pre-war concepts of the mechanism of street lighting and discussed the modifications required in design to match present day changes in the properties of road surfaces. The second part is concerned with recent experiments and new ideas about the function and practice of street lighting from the driver's viewpoint. Extensive abstracts from the paper are given here.

THE mechanism of seeing in lighted streets has been studied more carefully than in any other visual situation, and many of its aspects are fairly well established. It is interesting that many of the conclusions reached in the experiments about to be described were reached or foreshadowed in a paper given to this Association thirty-two years ago.[5] There are however still many questions unanswered, upon which turn the design and the cost of our installations.

The principal purpose and justification for street lighting is to make roads safer and it has been pointed out that the only final answer to any of these questions must be in terms of accident rates. But the first part of the Report of the Experts Committee of the C.I.E., presented last year at Brussels, points out that the connection between street lighting and accidents is tenuous, and accident statistics can be related to lighting only in a comparatively crude way. The Road Research Laboratory has shown,[6] and others have confirmed, that in good lighting the personal injury accident rate at night is about 30 per cent less than occurs in bad lighting ; but it is clear that more detailed answers will not be obtained from accident statistics in practicable investigations. We need a more discriminating tool.

A better method becomes possible if we examine the fundamentals more thoroughly. We say loosely that street lighting must reduce accidents ; but accidents are caused by traffic; lighting neither directly causes nor prevents them. The lighting is there not directly to reduce accidents, but to give information to road users ; when it has given them clearly all the information they need, with the appropriate emphasis, there is no more that lighting can do.

The question of safety and accidents can therefore be replaced by two others : (i) what is the information which road users need? and (ii) to what extent and by what mechanism is that information presented to them in the lighted street, and in daylight, and how do they compare?

Studies of the Driver's Requirements

The first problem is then to establish, in detail, what the driver needs to see. This cannot be done merely by asking a driver, for he is rarely conscious of his needs and actions. The problem was approached by three techniques. First, experienced experimenters drove in various conditions of road, traffic and weather, by day and night, and observed carefully their visual reactions, recording them on a tape recorder. This can be done with a little practice, though it is difficult at first to be both subject and observer, and language is inadequate even for the most fluent to describe all that they are doing. But a great deal was learned even by the effort to do so, more indeed than ever appeared in the records themselves ; the experiment trained the observation. Later, films were made in synchronism with the recordings, taken by day and night from a position as close to the driver's head as possible. The technique of taking films at night is difficult and was first accomplished by the Road Research Laboratory ; but after their example it was found possible to do so successfully. In this way the complete traffic situation could be captured for study. Some films were made which showed in addition the driver's actions on the car controls.

The observations were mostly made on a circuit in the form of a figure eight, with a circuit length of 12 miles, all lighted by sodium and fluorescent non-cut-off equipment to good modern standards, but varying from shopping centres and double carriageways to a sinuous country road with grass verges. Surfaces were mostly fairly smooth, though since the observations some have been relaid with very matt surface dressing.

A third very interesting study was made by the kind collaboration, which is gratefully acknowledged, of the Road Research Laboratory and the Medical Research Council's Applied Psychology Research Unit at Cambridge,† where Dr. Mackworth had evolved a very ingenious means for recording on film the eye movements of an observer viewing a scene.[7] It was not then possible to do so while actually driving a car ; but it could be done by a driver viewing a film taken by the Road Research Laboratory from a moving car, and looking at it as though driving. This is not perhaps quite convincing, but films taken of the eye movements of two drivers viewing identical traffic films showed general patterns of eye movement which were very similar, though with characteristic but unimportant individual differences ; and from this evidence and experience it is considered that the films can be taken as applying to driving conditions with no serious error.

The films showing the traffic record the information which is available to the driver ; the films showing eye movements give some idea of his procedure in selecting what he wants, and the films showing the car controls show something of what he does as the result. But none of the films can show what we really want to know, which is the mental process which he uses. The only way of ascertaining that is for the driver to tell us ; it follows that the commentaries are more important than the films. It is an interesting example of the fact that visual presentations are best suited to transmitting material facts, and language for transmitting ideas.

In interpreting the films of eye movement it is important to recognise that unless the driver's eyes are closed or he is looking out of the frame of the camera, his eyes must be looking somewhere ; but he is not necessarily giving acute attention to what he seems to be looking at ; he may be looking idly and thinking about something else, as happens in a traffic jam when he cannot move at all. It is also to be remembered when interpreting films showing his controls that even when a driver in traffic is not changing his controls but is proceeding at a steady speed, it does not mean that his mental processes are at rest. It may well take just as much judgment and decision to keep a steady speed as to make an emergency stop.

The driver's requirements can be classified under three conditions : driving without other traffic ; driving with normal traffic, and driving in very heavy traffic.

Driving Without Other Traffic.—The information required by the driver is simply the run of the road, and the fact that there is no other traffic on it or about to enter it. He drives with his eyes fixated usually a little on the offside and a few hundred feet ahead, steering the car by the centre line if it is visible either as a white line or a central joint, and by the " streamer effect " of the kerbs, which he does not fixate. The position of the kerbs is important, and they need to be seen clearly though they are not fixated ; but it is casual seeing, and he has opportunity to look about if he wishes to.

Driving in Medium Traffic.—In traffic the position is quite different. In addition to the run of the road, the driver is preoccupied by the gap through which he must manoeuvre his car. It is as though he were stationary, but with control on the lateral movement of the vehicle, while two rows of vehicles are drawn towards him, that on the offside coming at about twice his own real speed, and that on the near side—the stationary vehicles—at his own real speed. What is important is the gap between them, and the likelihood of its closing. He appraises this by recognising familiar patterns of traffic, learned by experience.

Two very important elements were found to be the stationary vehicle, and the bicycle. The stationary vehicle is the more important ; it can take no action itself, but it imposes action on everyone else. It closes the avilable gap and will make other vehicles pull out to close it further. Often a stationary vehicle can be seen only in part, and in a momentary glimpse, by very slight clues.

Bicycles being slower than cars act much like stationary vehicles in affecting the action of others, with the additional disadvantage that they can move sideways with agility and without warning. The observers found themselves fixating bicycles carefully, watching them " right under the wing " lest they should wobble—which means that bicycles claim an unfair amount of attention, which may well be needed for something ahead.

An interesting and most important observation was that drivers do not and cannot possibly fixate everything of importance ; they accept an enormous amount of important information by peripheral vision, at quite low detail. Cases were recorded and observed on the eye movement film of the driver not looking, for example, at an oncoming bus, but at a child on the footpath ; he knew that it was a bus and what it was doing, but he needed more information about something else. More insight into visual processes was obtained by noting what the driver observed on the footpath. Pedestrians were usually seen entirely by peripheral vision

* Research Laboratories of The General Electric Company, Ltd., Wembley, England.

† Conclusions drawn from this study are those of the author alone and are not necessarily those of either of the collaborating Laboratories.

and the driver was barely aware of them ; so long as they walked normally he discarded them. But should one turn to move towards the road, he immediately fixated him. This means that information about the presence and motion of the pedestrian was coming in, at very low detail, being appraised as unimportant and discarded again, scarcely entering the driver's consciousness. As soon, however, as a motion is detected which might be significant, the driver is alerted and fixates.

Now evidently it is very important that the driver should not be deceived about what he sees peripherally. It happened to the author and to some other observers that very occasionally he apparently misread a traffic element seen peripherally and thought that it was something else, and so he did not fixate it. That traffic element, therefore, did not exist in his consciousness or reckoning at all, and was not perceived till much later, to his astonishment and alarm. This is from time to time the experience of many drivers.

If the driver is satisfied about what he sees peripherally he does not fixate it unless he deems it to be critical. But if he is unsure of it, he will fixate it until he knows what it is. This is why bad lighting, in which the observer cannot be immediately sure of what he sees, makes such heavy visual demands.

The bearing of this on lighting practice is that it is very important that fringe objects shall be clearly seen by peripheral vision at low detail. This means that if possible the whole object should be clearly distinguished from its background by change of brightness. It is often maintained that objects are seen well enough by " glint " and by internal contrasts, or when one part is seen against a dark patch by reversed silhouette and another part against a light patch by normal silhouette. So they are, if they are fixated ; but such objects may not be correctly interpreted when they are seen peripherally, " out of the corner of the eye," when the eye cannot resolve detail at all. For this reason the author does not accept tests of " visibility " made by acuity test-objects such as Landoldt rings, which test the capacity to see detail when fixated. There are miles of lighted street in which nothing will ever be missed if it is seen against the carriageway and one looks straight at it; but what is more important and may be missed is the pedestrian or cyclist near the kerb, or on the footpath, not seen against the carriageway at all, but about to take dangerous action. It we light the margins properly the middle of the road will present no serious problems ; it is far less likely that anything which has got there will be overlooked. In model experiments in 1928 it was shown[5] that very small contrasts suffice for a fixated observer, which are quite insufficient to claim his attention if he was not fixated on the object.

Driving in Dense Traffic.—It is often contended that much traffic to-day is so dense that one sees nothing but the back of the vehicle in front, and silhouette seeing is no longer operative. It is also contended that in such conditions much more light is wanted.

Observations and films in dense moving traffic show that the first contention is wrongly observed. There is an important difference between driving in heavy traffic and in light traffic, but it is something else.

In medium traffic the driver is nearly always able to discard all the traffic elements except one critical one, and to concentrate on that ; his technique is to take the critical elements one at a time, and he manœuvres to secure that only one occurs at a time. What disconcerts him is to find that he has to watch two or more critical elements at once—e.g., an oncoming car closing his gap on the right, and a cyclist under his wing on the left. When that happens, he usually brakes. The difficulty in very heavy traffic is that he has several critical vehicles often on both sides of him, and the demand on his attention and decision becomes extreme. It is of course worse when speeds are high, for example, on the North Circular Road in the evening rush hour, rather than when held up in a block in the West End.

It does not follow that such conditions necessarily call for extra light, as compared with medium traffic. If the installation has been designed so that one can see any one vehicle clearly and accurately, and any element likely to impinge on the route, one can see twenty vehicles just as well. It takes no more noise to wake seven sleepers than to wake one. But such situations demand perfection ; one cannot risk missing an element of traffic, and one has no time for second glances or unnecessary fixations. It is not that these situations demand more light, so much as that in less dense traffic we may perhaps be content with less than perfection and accept greater visual risks, because there may be more time to rectify mistakes in seeing. Whether this is justified is debatable ; for there is not always such time, and very awkward situations making great visual demands can occur anywhere. The procedure of adopting half lighting in the small hours is not logical and has often been challenged.

Studies of the Revealing of Objects

Studies of the ways in which objects were revealed were made by several techniques by day and by night and at twilight.‡ The recorded driving commentary was again used, but directed to recording notes on objects seen clearly or otherwise, and the reasons why. In daylight the observer (not the driver, for safety) wore dark goggles which reduced the luminance of the scene to levels approximating to street lighting, to find whether the daylight mechanism would be effective at night levels. Colour photographs were taken in sunlight, up and down light, and luminance surveys made while stationary by daylight, at twilight and at night.

A general conclusion was that it was very difficult to deceive the driver about anything that he fixated, even in bad conditions ; one observer commented in a very poor installation that " the road lighting is very patchy and not very bright. It is a bit surprising, really, that one sees anything at all," but he seemed to be driving without difficulty. Though observers were very critical when commenting on the revealing of objects, when recording visual action later they referred to objects unerringly by name—" that cyclist ; that woman "—even when they were very difficult to see ; and they seldom commented on the difficulty of seeing. It was surprising to find how little information sufficed ; but that is not evidence that it was enough to be safe. We often drive momentarily blind, yet if everyone keeps the rules we do not hit anything : a sense of false security builds up, to the point where some drivers must be taking serious risks.

Daylight Vision.—The difference between daylight and night vision is, of course, first, that the sky is bright not dark, and second, the great change of level ; this enables observers by day to perceive with great facility detail which would be quite overlooked at night, even when fixated. There is so much detail visible by day that it is difficult to discern the visual processes.

An important difference between daylight and night is that in daylight the road and footpaths are uniformly bright, and that there are no repetitive effects as objects move along the road such as occur at night. The contrasts between object and background tend to be unvarying.

Colour difference is usually very important, by day, and can sometimes be more important than brightness difference. Colour

‡ The methods here described are similar to those used in 1935 by Davies, Maxted and Lucas,[3] and later by F. C. Smith,[4] whose papers record some similar conclusions.

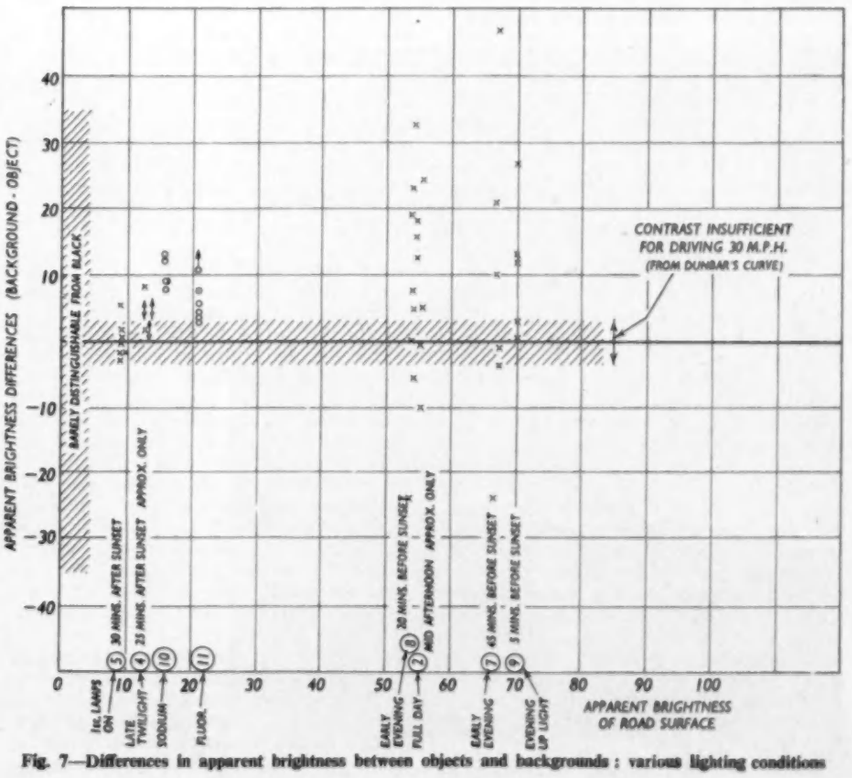


Fig. 7—Differences in apparent brightness between objects and backgrounds : various lighting conditions

was the major factor in seeing in sunlight when looking down light, but colours could hardly be discerned when looking up light. The reasons are easy to follow from the geometry and reflection properties. Up light the conditions are much more like street lighting at night, and similar effects of silhouette occur. Thus by day objects are seen by both brightness contrast and by colour contrast, and details of both brightness and colour pattern are important.[5] The upper parts of objects are often seen against the bright sky, especially at or beyond a hump. Cars are seen largely by the shadow below the body, the wheels and differential casing. Their upper parts usually reflect the sky as a bright glint, and the body colour is often quite difficult to see from the rear.

By overcast daylight relative luminance differences tend to be comparatively feeble, but are very easy to see owing to the much higher level of luminance and the enhanced contrast sensitivity. When they were reduced to night levels by dark goggles, observers found that the contrasts were quite inadequate for safe driving. This confirms results obtained in model experiments in 1928.[5] The mechanism used in street lighting employing the properties of the road surface resulted in greater relative luminance differences which could be well seen despite the lower levels.

This was investigated quantitatively, by first making a survey of the luminances with a telephotometer by day, twilight and at night, and then applying Hopkinson's curves to transform these figures into values of apparent brightness which are more closely related to what we see, allowing for effects of adaptation. Dunbar's work can be shown to indicate that a difference of about three units of apparent brightness represents the contrast needed by a driver for sure seeing at 30 m.p.h. Some results appear in Fig. 7.

During the day the relative differences of luminance were found to be not high, though they vary with the direction of view relatively to the brightest part of the sky ; but the capacity of the eye to adapt and so to compensate for changes in level resulted in these differences being seen as quite high contrasts, even when the level of daylight had fallen. The apparent contrasts by day were either positive or negative, i.e. either direct or reversed silhouette ; because their range was large, very few objects presented a difference which was too small for sure discrimination, and even these are usually well revealed by details.

At late twilight, just at lighting-up time, however, the adaption mechanism is reaching its limit and the contrasts as seen become small, most of them falling within the limit where contrasts are too small for certain discrimination, which confirms the usual experience.

Street Lighting Conditions.—By street lighting, the conditions for producing contrasts with a small amount of light are better than by day ; and Fig. 7 shows that the differences in apparent brightness are greater than at late twilight, lying mostly outside the uncertain region, and all on the side of normal silhouette. They are, however, much less than by day. Levels of lighting, say, up to an order higher, would produce greater apparent contrasts and more certain seeing, possibly with advantage, though drivers were seeing satisfactorily in such poor conditions that it is scarcely possible to make a strong case for much higher levels of luminance than at present. We do not know with certainty how much we need ; the contrasts in full daylight may be over generous.

Indeed, in nearly all the installations, by both sodium and fluorescent lighting, it was concluded that drivers were given all the information which they needed in dry weather and with moderate traffic. However, any circumstances tending to impair the installations, such as obstruction by a tree, could result in lost information. The least satisfactory information was of objects seen against fences, which were sometimes quite inadequately displayed. Another feature of streets to which insufficient attention has been given is the *slight* vertical hump curve.[3] This has often the effect of removing all the effective street surface background, and leaving objects on the crest or beyond it with only a background of haze or of a medley of distant and often lighted buildings, against which it could easily be lost. The conditions are much worse than in daylight, for there is no bright sky. Furthermore, the hump brings distant lanterns much lower into the field of view, increasing glare and causing confusion. Mr. J. G. Holmes reported a serious accident associated with poor visibility in these conditions.

By night objects are very rarely seen as the result of colour contrast, and the general difference of brightness is the most important parameter. There is often a significant change in brightness between the upper and lower parts of objects, and these parts are often seen against different backgrounds. The background of the lower part is often the carriageway, and that of the upper part the dark sky, in fact, illuminated haze. At a hump the lower part of an object just past the crest may lie in dead ground and so be physically invisible.

Most of the carriageway surfaces encountered during the experiments were fairly smooth ; one was almost a prewar section, and was notable as greatly superior to the remainder. Glare was not troublesome, even to an experienced Continental engineer, except at one place where a vertical curve on a long straight section resulted in distant lanterns appearing unduly low in the field and in considerable numbers, and on a double carriageway section with many lanterns in the field of view. However, resurfacing with a dark matt surface in an exactly similar installation was disastrous.

True disability glare is difficult to identify ; it is hard to distinguish it from effects of discomfort. However, there are good reasons[8] for expecting it to have most effect in the regions in which seeing is in any case difficult, such as at the edges of the road for objects seen against the footpath, and something of the kind has been observed in installations with severe glare. An effect which can be quite serious is the flash on a wet or dusty windscreen, which operates analogously to disability glare. In cut-off lighting this can be disturbingly repetitive.

It is remarkable that to a driver colour is scarcely seen as such at night, though it is more important to pedestrians. Even in good fluorescent installations, and indeed in the Champs-Elysées in Paris, where a very powerful installation of excellent colour rendering exists, colours were not seen while driving, as was confirmed by Continental drivers. That is not to say that there are no significant effects associated with colour ; unaccountably low contrasts have been observed which may be associated with sodium light, but the reasons are very difficult to identify.

It is probably too early to draw conclusions about patchiness. Such experience as there has been on very patchy Continental installations at short spacing and high level without formal experiment, seems to indicate that it may not be serious ; but the principal danger may lie in the peripheral effects mentioned above, which would require longer experience with more traffic to establish it. Patchiness is usually and probably rightly considered as a blemish, especially when its pattern conflicts with that of the road geometry ; but no satisfactory or proven method exists yet for appraising it, though the uniform brightness experienced by day is clearly advantageous compared with the more patchy effects at night.

General Conclusions

The changes which have taken place in road surfaces will inevitably lead to installations of greater mounting height and less spacing-height and width-height ratio, probably with spacings not much changed from those now in use, and with modified light distributions. Glare will be less than has been experienced recently in some non-cut-off installations.

The powers of installations will have to be somewhat increased if only to take account of the more matt surfaces ; but the question whether considerable further increases in level are required is still hard to answer in detail. Existing installations when well designed appear to give the driver adequate information in dry weather except for obstacles off the carriageway, which need to be made more conspicuous ; it may be that attention should be concentrated upon the margins of the road rather than on the carriageway itself. These installations have, however, little in hand. Apparent contrasts under street lighting conditions are still well below those in daylight, and an increase in luminance of about one order might give substantial increases in contrasts. On the other hand, drivers can evidently work well with very low contrasts, and the real need for substantial increases in street lighting level has still to be made out. In very heavy traffic where the visual demands are acute it is essential that the lighting should be beyond criticism, which may involve higher levels than are in use at present ; but not necessarily more than is really needed for less traffic if the drivers' needs are to be properly met.

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[5] Waldram, J. M., "The Visibility of Objects in Artificially Lighted Streets," A.P.L.E., 1928.

[6] Glanville, Sir W. H., "Light and Road Safety," *Trans. I.E.S.*, 25, 69 ; 1960. (Summary of earlier papers.)

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Thermal Relays

Newly designed thermal relays introduced by Coventry Controls, Ltd., Godiva House, Allesley Old Road, Coventry, are stated to have characteristics with respect to vibration, shock, acceleration and temperature which make them particularly suitable for missile environments.

The design employs the basic principle of longitudinal expansion of a heated stainless steel member, to secure positive and uniform response to temperature rise. This response is multiplied by a new double-stage amplifying mechanism to produce contact motion twenty times as great as the expansion. Despite this magnification, the mechanism has no resonant response below 2000c/s.

The external design of these "GD" relays also departs from previous practice. The structure is mounted flat in a rectangular metal case, minimising the height above the mounting panel and reducing the stresses which can be produced by severe vibration in both relay and panel. [Reply Card No. E6341].

Expansion of Rogerstone Aluminium Strip Mill

No. I

When the continuous aluminium strip mill was installed at Rogerstone in 1949/50, provision was made for considerable expansion. New plant has now been installed which not only enables the strip output to be increased, but also makes available rolled plate in much greater widths than hitherto obtainable

THE works of Alcan Industries, Ltd. (formerly known as the Northern Aluminium Company, Ltd.) at Rogerstone, Newport, Monmouthshire, were originally designed for rolling strip in commercially pure aluminium and a 1¼ per cent manganese alloy. The mill produced building sheet, container sheet, foil stock, circles for hollowware, and hot-rolled coil and plate. It was envisaged that there would be an increased demand for these products, and the plant was so designed and installed that extensions could be made with the minimum of difficulty. When the time came for the new plant to be ordered, two other factors had appeared. Demand for stronger alloys had grown, and there was a need for much larger plates than the original mill could roll. The new plant had, therefore, to be much larger and more powerful ; at the same time it has been incorporated into the existing layout in such a way as to render the complete unit much more versatile and flexible. Outstanding among the products of the new plant is hot-rolled plate up to well over 10ft wide and up to 50ft long.

Slab ingots for rolling are made by remelting commercial-purity aluminium, alloying it, and casting it by a semi-continuous process. A new remelt department, with facilities for casting ingots up to a maximum of about 8 tons, if required, will be in production in 1961, but the local casting capacity will still, for convenience, be augmented by importing rolling ingots in certain alloys from Canada. This new department will be designed as the initial stage of a remelt department which will serve the mill to its ultimate capacity.

A separate swarf remelt department is used to recover swarf and certain types of scrap. It was originally equipped with four induction furnaces and was on the site required for the new mill. The relocated department is equipped with only two of the original furnaces, which have been uprated and enlarged to process the increased quantity of swarf and scrap associated with the increased output. The casting unit served by the furnaces has been improved to permit the casting of larger ingots. In rehousing this department, special attention has been paid to working conditions, particularly with respect to fume extraction, and two new systems are fitted over the furnaces and dross pit. Fumes extracted by both systems are cleaned before being discharged.

The cast ingots are " scalped " before rolling. This operation machines the face of the ingot to improve the surface of the finished product. Existing scalping facilities are being modified to deal with the increase in production under the present scheme. After scalping, the ingots are pre-heated ready for rolling (Fig. 1). As the existing furnaces were unable to deal with the increased size of ingot and volume of production, four new Swindell-Dressler furnaces have been installed to supplement the existing equipment.

The new furnaces are indirectly heated by passing air over banks of oil-fired radiant tubes, so that the ingots are protected from the products of combustion. Air, supplied by twin " Garden City " centrifugal fans driven by a 75 h.p. motor at 550 r.p.m., is drawn over the radiant tube bank and

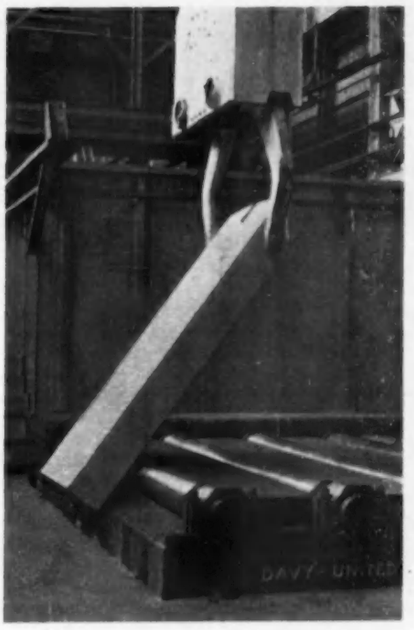


Fig. 2—Heated ingot being placed on mill table

discharged into plenum chambers at the base of each furnace pit. It then passes up through the load, which is supported by a grill, and is recirculated. The operational range of the furnaces is up to 600 deg. Cent. (pre-heating temperatures for aluminium

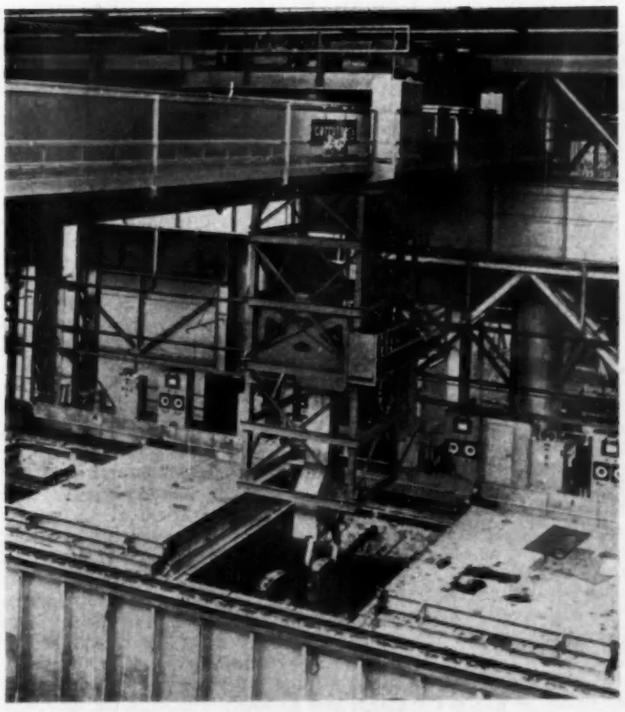


Fig. 1—Ingot being charged to furnace

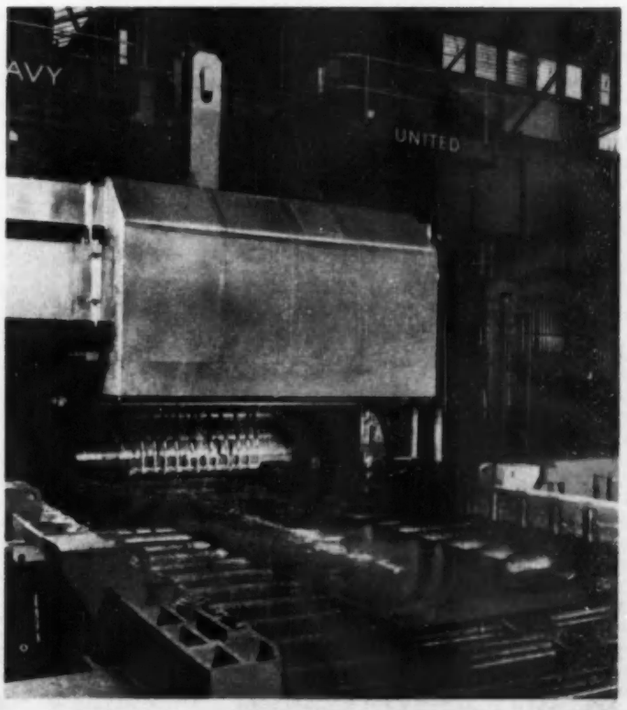


Fig. 3—Detail of 144in mill

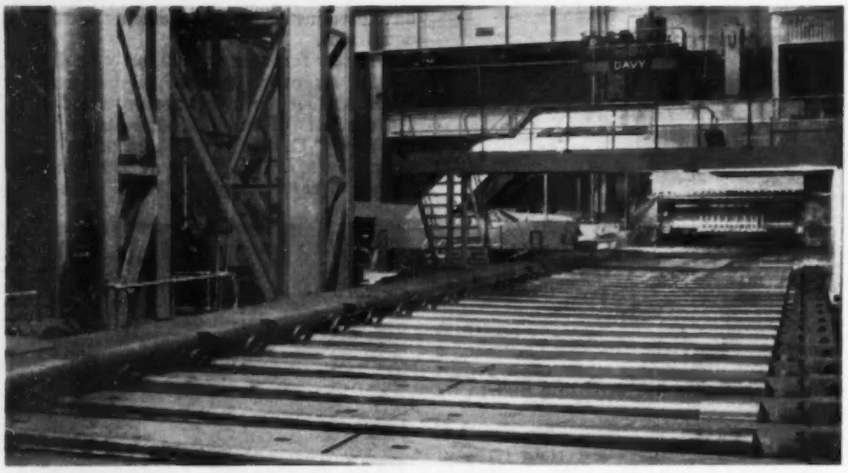


Fig. 4—Mill table with 144in mill in background

alloys range from 480 deg. Cent. to 600 deg. Cent.) and the basic performance of a hot furnace is to bring a full load of cold ingots to 600 deg. Cent. in approximately eight hours at a heating rate of 17×10^6 B.Th.U. per hr. The 2352 cubic feet capacity of the furnace can take, for example, a full charge of twenty-two ingots, 13in by 48in by 120in, standing on end and weighing in all 75 tons. The annual capacity of these furnaces is 30,000 finished tons, thus bringing the total ingot preheating capacity to 75,000 finished tons.

A mild steel shell, lined with refractory fire brick and hot-faced insulating brick, houses the furnace, the inside dimensions being 14ft wide by 12ft long by 14ft deep. The load-supporting grill is at floor level and beneath it is the plenum chamber that distributes the hot air. The furnace lid is in one piece, constructed of stainless steel panels with glass-wool insulation, and is sealed by asbestos strip.

A most important factor in planning the handling operation in this bay was the need to keep to a minimum the time in which the pre-heating furnaces remain open, and to this end high operating speeds were required. An ingot handling crane, designed and installed by J. H. Carruthers and Co., Ltd., Glasgow, deals with this problem satisfactorily. Armchair Igranic control is provided in an underslung, insulated and air-conditioned cabin, giving the operator a direct view into the furnace. The main hoist, which is in the form of rotatable tongs with an opening range of 2ft 6in to 7ft, has a maximum lift capacity of 8 tons. Particulars of the crane are :

Span	100ft
Long travel	240 ft
Down-shop speed	400ft per min.
Cross-traverse speed	200ft per min.
Main hoist speed	120ft per min.
Lifting range	28ft 6in
Conventional auxiliary hoist	10 tons
Total	110 tons

It is expected that the pre-heating capacity will eventually be increased considerably, at which time an ingot buggy will be provided to deliver the hot ingots to the feed table. Under the present expansion scheme, the pre-heat and rolling capacity is such that the ingot handling crane can both load the furnaces and transfer the pre-heated ingots to the feed tables of the mill.

A steel-framed cover lifter of 10 tons capacity, made by Fred Gilbert (Cardiff), Ltd., is mounted on rails, on the top of the furnaces, which extend over a cover storage rack. It has a rail speed of 120ft per minute. A hoisting frame is lifted by four interconnected pulleys and engages fixed hooks on the furnace cover. The lifted cover may be placed on any of the adjacent furnaces or on the cover storage rack. The operator's cabin, side mounted, is screened from the furnace up-draft by anti-sun glass.

Heated ingots are deposited by the crane on a roller table leading to the 144in mill (Figs. 2 and 4). This table extends 85ft from the pre-heat bay to the ingoing table of the mill, and contains thirty-one separate rollers, 144in long. The rollers are of diabolo shape, made of solid forged steel, and ground to a taper of 1 in 20. They are generally placed at 36in centres and are driven through a line shaft and bevel gears by 75/150 h.p. A.E.I. mill motors. The table can be controlled in sections or as a whole by the operator in the control cabin.

The main entry table is of the turning pattern, 24ft long and 18ft wide; it is formed by fourteen split conical cast-iron rollers, each 97in long and tapered 1 in 197, which are generally placed at 21in centres. Each side of the table is driven by a single 75/150 h.p. A.E.I. mill motor through line shaft and bevel gearing.

Hydraulically operated guides, actuated by a synchronised rack and pinion, are positioned on either side of the table. Once the ingot has been centred, a short stroke of 8in can be employed which will speed up passes and ensure that when very long slabs are rolled deviation from the centre on the ingoing side is kept to a minimum. Rollers are fitted to the faces of the guides.

The feed table is a separate unit, with four forged-steel split-conical rollers, each 4ft 6in long (10ft wide overall) and mounted in a frame 14ft wide. The rollers are driven through closed spur and idler gears by a 13 h.p. A.E.I. mill motor. The table is mounted on an eccentric shaft which is used to adjust it to the pass-line level after roll grinding. It can also be pivoted on the driven roll, which is the outermost, and raised to an angle of 53 deg. by a hydraulic pusher situated in the underframe. When the mill rolls are being changed, the table is latched in the raised position to get the strippers on the front of it clear of the roll chocks.

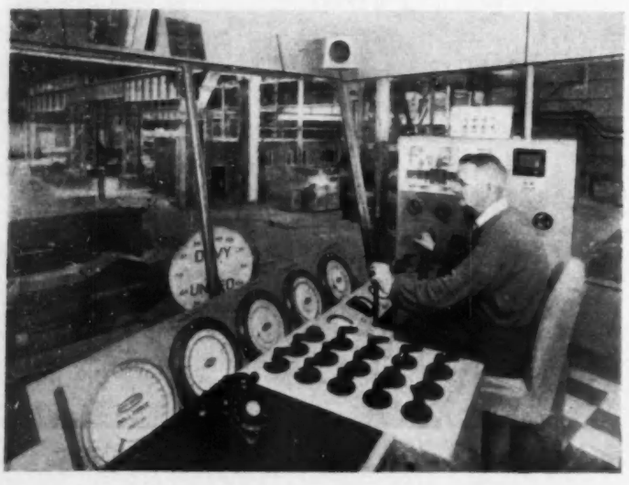


Fig. 5—Controls for 144in mill

Hot Roughing or Finishing Mill

The major item installed in the expansion programme is a 38in and 60in by 144in four-high, reversing, hot mill (Figs. 3 to 5) which has been built and installed by Davy and United Engineering Company, Ltd., who also supplied the mill tables. It is designed to act either as a hot roughing mill, the first stage in the sequence of the hot line, feeding an existing 96in mill ; or, independently of that line, as a plate finishing mill. The mill is designed to roll ingots 16in by 80in by 138in weighing up to 17,600 lb. But maximum roll opening is 25in, so that ingots up to that thickness can be rolled in special cases as long as they do not exceed the maximum table loading. Normal duty is either to roll slab 1¼in thick for further reduction on the hot line or, alternatively, finished plate down to a minimum thickness of ¼in and up to maximum width from the mill of 134in. The rolling speed is 298/596ft per minute. The 144in mill is positioned at the head of the hot line in a new bay set at right angles to the original buildings. This bay also houses new roll grinding equipment and the brick-enclosed 144in mill motor room, which is isolated from the main area.

The 144in mill housings, cast by English Steel Castings Corporation, Ltd., each have a finished weight of 163 tons and measure 33ft by 15ft wide overall. The mean cross-sectional area of each post is 1420 square inches.

There are two screwdown speeds ; the faster, 25in/50in per minute, is used for normal operations. A speed of ¼in/1in per minute is used for screwdown adjustment whilst under load. This second speed will be used in conjunction with a gamma-ray thickness gauge and can at a later date be used with automatic gauge control. Two 200/400 h.p. A.E.I. mill motors, mounted on a platform 19ft above floor level, drive the screws through a 30in Igranic multiple plate clutch and an electrically-operated gear box. The 20in diameter screwdown posts, made of

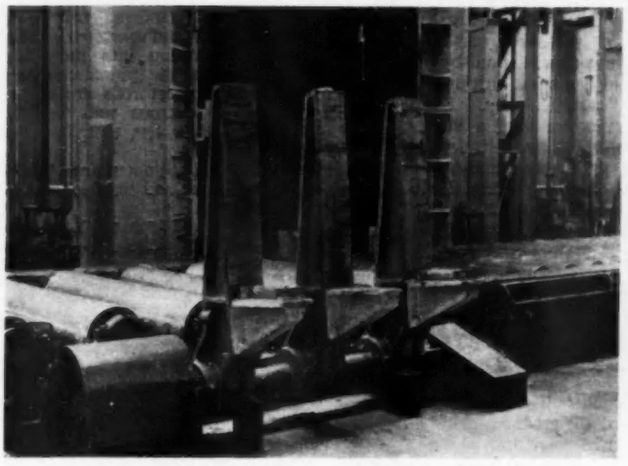


Fig. 6—Ingot tilter on the hot line

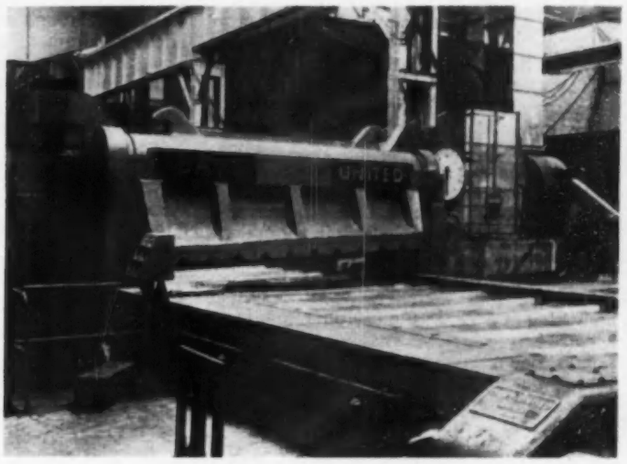


Fig. 7—Slab shear on outgoing side of 144in mill

forged steel, have a 1in pitch buttress thread fitted in high-tensile bronze boxes set in the housings. The posts act on loadmeters on the top back-up roll chocks, and loads are recorded in the control cabin, from which each screw can be separately operated. A Selsyn unit records gap measurement, and limit switches prevent over-running.

The 38in diameter work rolls, which weigh 27 tons each, were supplied by William Beardmore and Co., Ltd., Glasgow, and Thomas Firth and John Brown, Ltd., Sheffield. They are made of alloy forged steel, 65 deg./70 deg. Shore hardness. The minimum diameter to which they may be ground, without affecting the face hardness, is 35⅝in. The rolls are carried in double-row cylindrical and spherical thrust bearings made by the Skefko Ball Bearing Company, Ltd., Luton, and are held in cast steel chocks. The lower work roll chocks are fitted with hydraulic balancing pushers, operating on the top work roll chocks at 1 ton per square inch.

The 60in back-up rolls each weigh 68 tons, and were supplied by the United Engineering Foundry Company, U.S.A., and by William Beardmore and Co., Ltd. The rolls made by United Engineering are of special alloy, 45 deg./50 deg. Shore hardness. Those supplied by William Beardmore are of composite construction, with a forged sleeve (of 50 deg./55 deg. Shore hardness) on a cast arbor. These rolls may be ground to a minimum diameter of 57in without affecting hardness. The roll necks are tapered 1 in 30, and support multi-row Skefko cylindrical and thrust bearings.

The top back-up roll chock is latched to a yoke connected by hangers to a forged steel crosshead, which is in turn fixed to a 30in diameter balancing cylinder working at 2 tons per square inch. This cylinder is fitted in the centre of the top housing separator.

The work rolls are driven at between 30 and 60 r.p.m. (298/596ft per minute strip speed) by two direct-coupled, 4000 h.p., single-armature d.c. motors supplied by Associated Electrical Industries, Ltd., Rugby. A " top forward " arrangement is used in which the top work roll is driven by the front motor. The rear motor, which is coupled to a jack shaft carried under the front motor, drives the bottom work roll. This arrangement offers easier access for maintenance on the front motor than is possible in the conventional installation of mill drives. The motors are coupled to the work rolls by forged steel spindles with universal couplings at each end. The top spindle is supported by a carrier bearing mounted in steel beams, pivoted and balanced at the motor end, and hydraulically balanced at the mill end. The lower spindle, between the jack shaft and the bottom work roll, is set in spring-balanced carrier bearings at the motor end, and is hydraulically balanced at the mill.

The roll chock assembly, which is mounted on a sledge, lies on the bottom housing separator. All four rolls, or the bottom back-up and two work rolls only, can be withdrawn sideways from the mill on the sledge, which is connected to a rack beam running through a totally enclosed double reduction worm and worm wheel gearbox driven by a 75 h.p. motor. The exposed rolls, with the bearing chocks supported on stools, are removed by a 125 ton crane to the roll-grinding machine, situated in the same bay.

Soluble oil coolant is supplied from a 34,000 gallon main storage tank by four 1000 g.p.m. " Pulsometer " centrifugal pumps at 120 lb per square inch. The " Pulsometer " pumps are assisted by a 250 g.p.m. automatic pressure-booster pump.

Coolant is pumped through a 16in Plenty duplex strainer to a battery of three automatic " Auto-Klean " strainers operating on a differential pressure switch each capable of passing 1000 g.p.m. and filtering particles down to 0·006in. A Kent combined pressure/flow indicator, with flow recorder, is placed in the line and leads to a " British Arca " control set, remotely operated from the desk in the 144in mill control cabin. This control set can isolate the supply whilst leaving the pumps in operation.

The coolant sprays are operated from the control desk through special Saunders diaphragm control valves, of which 122 are installed at the mill. Six thousand feet of ¾in outside diameter nylon tube are used between the control desk and the sprays, which permit a maximum flow at the mill of 3000 g.p.m. Coolant, having passed through the sprays, falls to a catch tray under the mill where it is drained to a 20,000 gallon collecting tank in the oil cellar. Three 15,000 g.p.m. 10ft-head " Pulsometer " vertical spindle return pumps are provided in this tank for returning the coolant through the cooling tower to the main 34,000 gallon delivery tank in the pumphouse. These pumps are float-controlled, and are fitted with a high-level alarm which can automatically cut out the main delivery pumps. The booster pump is left running to permit a flow of oil over the mill in case rolling is in operation.

A bank of five electric heaters, installed in the coolant system, enables the oil to be heated to temperatures of up to 150 deg. Fah. Excess heat gained when rolling is dissipated through a reinforced concrete cooling tower built by the Davenport Engineering Company, Ltd. Fumes from the coolant at the mill are removed by an exhaust system made and installed by the Visco Engineering Company, Ltd., and having a capacity of 70,000 cubic feet per minute. Fabricated aluminium hoods are fitted on either side of the mill stand and are connected by aluminium ducting to a large aerofoil centrifugal extractor fan made by Keith Blackman, Ltd. This 65in diameter fan is driven by a 100 h.p. motor and will absorb 92 b.h.p. at 800 r.p.m., a speed that gives the system a rating of 6in water gauge. An oil eliminator is provided to separate and recover the coolant from the exhaust gases. It is then returned to the soluble oil system.

Auxiliary Equipment

Gamma-ray gauge equipment, two ingot tilters, a slab shear and plate handling equipment are positioned between the 144in mill and the 96in mill approach tables.

The gamma-ray gauge is mounted on a swivel stand at the side of the ongoing tables and relays the gauge of the metal being rolled to a recorder in the 144in mill control cabin. Screwdown adjustment can be carried out, in conjunction with this equipment, during rolling.

Two three-prong ingot tilters (Fig. 6) of 6000 lb capacity are provided on either side of the slab shear. Hydraulically operated, they receive ingots vertically and lower them through 90 deg. on to the tables. The tilter nearest the mill will receive ingots from the tunnel pre-heating furnaces, while the plate that has just been rolled is being sheared and lifted from the table. The other tilter, on the run-out table from the shear, will take ingots which are to be rolled by the 96in mill when the 144in mill is rolling plate.

The slab shear (Fig. 7) is a vertical down-and-up-cut Davy and United machine. It has a capacity of $1 \cdot 25 \times 10^6$ lb and is designed to shear hot slab and plate having a maximum cross-sectional area of 300 square inches at temperatures between 400 deg. Cent. and 500 deg. Cent. The blades, 146in long with a rake of ½in, are driven by two 400 h.p. A.E.I. low-inertia motors, fitted with a 30in Igranic brake. Cutting speed is eight or sixteen cuts per minute at half or full power respectively. The shear is fitted with hydraulic arrester gear, operating at 1500 lb per square inch, to hold the plate and prevent marking during the cutting operation. It is also provided with hydraulically-operated guides on the entry side to square up and centre long plates or slab before shearing. An underground

conveyor carries the sheared ends to a crop shear, which cuts them to a manageable size ; they are then lifted and deposited in scrap bins at floor level.

A system of transfer beams, fitted over the tables immediately after the shear, removes finished slab or plate to the ingot storage bay, or loads it on to a plate car for transfer to the plate stretcher and processing department.

Lubrication systems for the 144in mill and auxiliary equipment are located in a 25ft deep oil cellar, on the outgoing side of the roll change side of the mill.

For the mill tables there is a system consisting of a 7300 gallon settling tank from which two Mirrlees positive-displacement pumps (one a stand-by) deliver at 225 g.p.m., through a fully automatic " Auto-Klean " strainer and a pressure vessel, to all the tables. The screwdown and screwbox systems have a common 1800 gallon settling tank. Two Mirrlees positive-displacement pumps (one a stand-by) deliver oil to the screwdown at 45 g.p.m. through a fully automatic " Auto-Klean " strainer and a pressure vessel. Two further Mirrlees pumps (one a stand-by) deliver to the screwbox at 5 g.p.m., through a manual " Auto-Klean " strainer only.

The slab shear system consists of a 960 gallon settling tank from which two Mirrlees positive displacement pumps (one a stand-by) deliver at 30 g.p.m., through a fully automatic " Auto-Klean " strainer and a pressure vessel. The soluble oil lubrication system for centre bearings consists of an 800 gallon tank from which two " LaBour " pumps, (one a stand-by) deliver to the centre bearings on the turning tables and to the ingot tilters at 40 g.p.m., through a manually operated " Auto-Klean " strainer.

Further lubrication is catered for by Farval equipment, sited at mill floor level. Roll necks are lubricated by grease and oil mist from the screwdown platform. All return pipes are set at a fall of 1 in 18 back to the cellar tanks.

(To be continued)

Frame Grid Valve Manufacture

AFTER several years of proving in industrial and communications service, frame grid valves became a feature of numerous domestic television receivers in the Radio Show of 1959. Their possibilities in this field have caused them to become a significant part of the valve production of Mullard, Ltd., Mullard House, Torrington Place, W.C.1. Five Mullard factories are contributing to the output of frame grid valves, and a visit was arranged recently to the frame grid production unit of the company's Mitcham works where the processes used were demonstrated.

The high slope of the mA/V characteristic of the frame grid valve arises from the very small grid-cathode spacing made possible with this

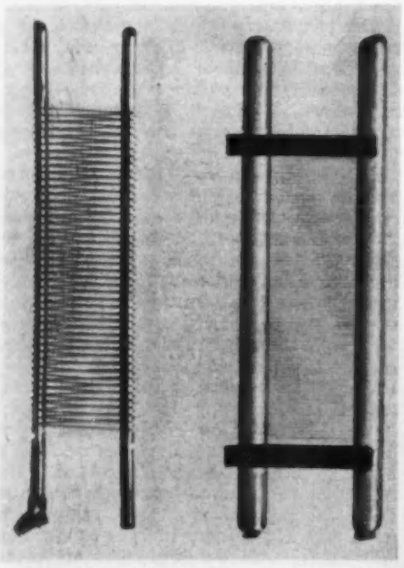


Fig. 1—Conventional grid (left) compared with frame grid (right)

form of construction. A typical conventional valve—the EF 80—has a slope of 7·4mA/V and a spacing of 100 microns. The frame grid valve EF 184 gives a slope of 15mA/V chiefly because its grid-cathode spacing is reduced to 50 microns. To achieve spacings of this order, the grids must be wound with wire having a diameter of only 10 microns, or one-fifth the diameter of the average human hair. Final reduction from 12 to 10 microns is obtained by electrolytic etching. With such fine wires the structure of a conventional grid would be impracticably weak. In the frame grid, therefore, the necessary strength, rigidity and dimensional control are achieved by making the backbones of stiff molybdenum rods, held a determinate distance apart by spacing bars. This structure provides a rigid, precisely dimensioned frame on which wire of any desired thinness can be wound, the strength being in the frame, not the winding. Fig. 1 shows a conventional grid and a frame grid beside it, the latter view showing the bars providing the strength which in the normal grid construction is supplied by the winding wire. Based on this principle, methods have already been developed for producing quality valves to special tolerances. In a triode designed to these standards there may be only 200 microns between grid and anode, requiring specialised design of anodes and of instruments for assembly. Such a valve may have a grid-cathode spacing of 25 microns.

During a tour of the Mitcham works the production of the basic " ladders," nearly 3ft long, of molybdenum rods and spacers was seen, followed by their separation into individual frames. The tolerances on the grid components are extremely small ; support rods are drawn to an accuracy of ±5 microns and the grid wire to ±0·2 microns, or less than half the wavelength of sodium light.

The grid-cathode spacing is determined by the diameter of the backbones and the thickness of

Fig. 2—Securing the wire to a frame grid " ladder " by welding on a strip of nickel

the cathode. To prevent deformation, the tungsten grid wire is wound under tension, and the total force exerted on each backbone in a complete grid may be as much as 4 lb. The entire structure must maintain its shape not only during eventual use, but also through the processing of the valve at temperatures up to 900 deg. Cent. At Mitcham the wire is fixed by glass deposited by a nylon wheel rotating in a glass suspension but elsewhere a nickel strip is welded to the frame, as seen in the illustration of this process at the Blackburn factory of Mullard,

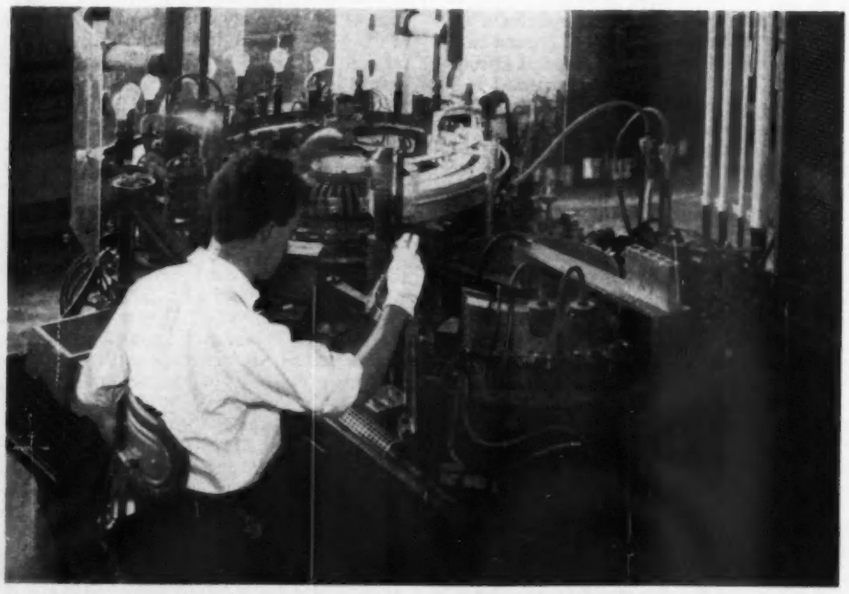


Fig. 3—Pumping and sealing unit for double-triode television tuner valves

Ltd. (Fig. 2). Frames and wires are gold plated to reduce grid emission.

Double-triode PCC89 valves for television

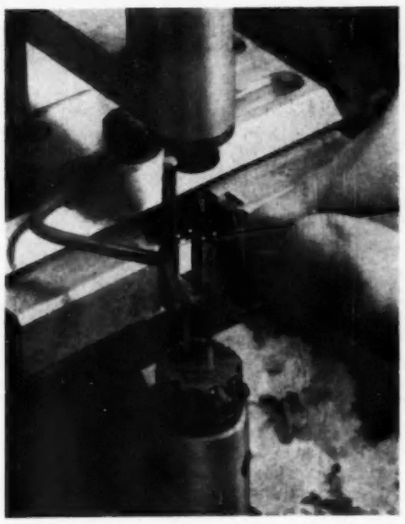


Fig. 4—Positioning the grids of a double-triode over their cathodes

tuners are assembled at the Hove factory (Fig. 4) but sent to Mitcham for insertion into their envelopes and finishing. The pumping and sealing unit for these processes is seen in Fig. 3. In this plant the glass is outgassed by an electric oven, metal parts are outgassed by an r.f. field, and cathodes are activated. Finished valves were seen undergoing noise comparison tests with standard diodes, and a test with normal applied voltages which lasts for twenty-four hours so that the valve performance can be checked after the initial variations have subsided. In the laboratories a method of comparative testing for tuners was shown in which tuners with frame grid and conventional valves were connected in turn by a high-speed switching circuit operating at frame frequency to a common i.f. and detector circuit. In this way a composite picture was produced, permitting direct visual assessment of comparative noise levels.

Shearing Machines

HIGH-SPEED shearing machines recently added to the " Keetona " range made by Keeton Sons and Co., Ltd., of Sheffield, are now available in a capacity range of 78in by $\frac{1}{4}$in, 50in by $\frac{1}{4}$in, 78in by 14 S.W.G. and 50in by 14 S.W.G. The $\frac{1}{4}$in capacity machines operate at seventy-six strokes per minute and the 14 S.W.G. machines at sixty-five strokes per minute.

The machines are of welded steel box construction, and have cutting beam slideways lined with non-metallic plastic material to prevent scoring and minimise friction. An automatic hold-down beam swings on lever arms operated by springs in the cutting beam and moves with the cutting beam during the cutting stroke until it comes into contact with the material to be sheared. Thereafter, the cutting beam movement continues, compressing the springs which apply an increasing load on the hold-down beam during cutting.

A full length treadle operates a spring-loaded clutch with nine hardened jaws. Normally the clutch is automatically disengaged at the end of the cutting stroke, but by setting a plunger in the gear guard, the machine can be set for continuous operation so long as the treadle is depressed.

Two large eccentrics on the drive shaft operate the cutting beam through connecting links and the drive is taken from the motor through vee-ropes to a high-speed flywheel which, in the case of the 14 S.W.G. capacity machines, constitutes the main drive wheel. In the $\frac{1}{4}$in capacity machines there is a pinion and gear coupling between the flywheel shaft and the main drive.

[Reply Card No. E6391]

Rig for Testing Lubricants under Gamma Irradiation

A RIG for the dynamic testing of greases under conditions like those obtained in gas-cooled " Magnox " reactors has been developed by the Mobil Oil Company, Caxton House, Westminster, London, S.W.1. This rig is known as " Setra " (submerged, elevated temperature, irradiation apparatus) and its design is based on a survey of reactor operating conditions which showed that gamma radiation predominates in those reactor components that need lubrication. Accordingly the " Setra " rig was designed to operate in the fuel element irradiation pond at Harwell, in which a high gamma flux can be obtained. There it is possible to apply, in a period of a few weeks, radiation doses equivalent to the highest that can be expected from several months' in-pile irradiation ; moreover it is possible to irradiate larger quantities of lubricant in assemblies of reasonable size.

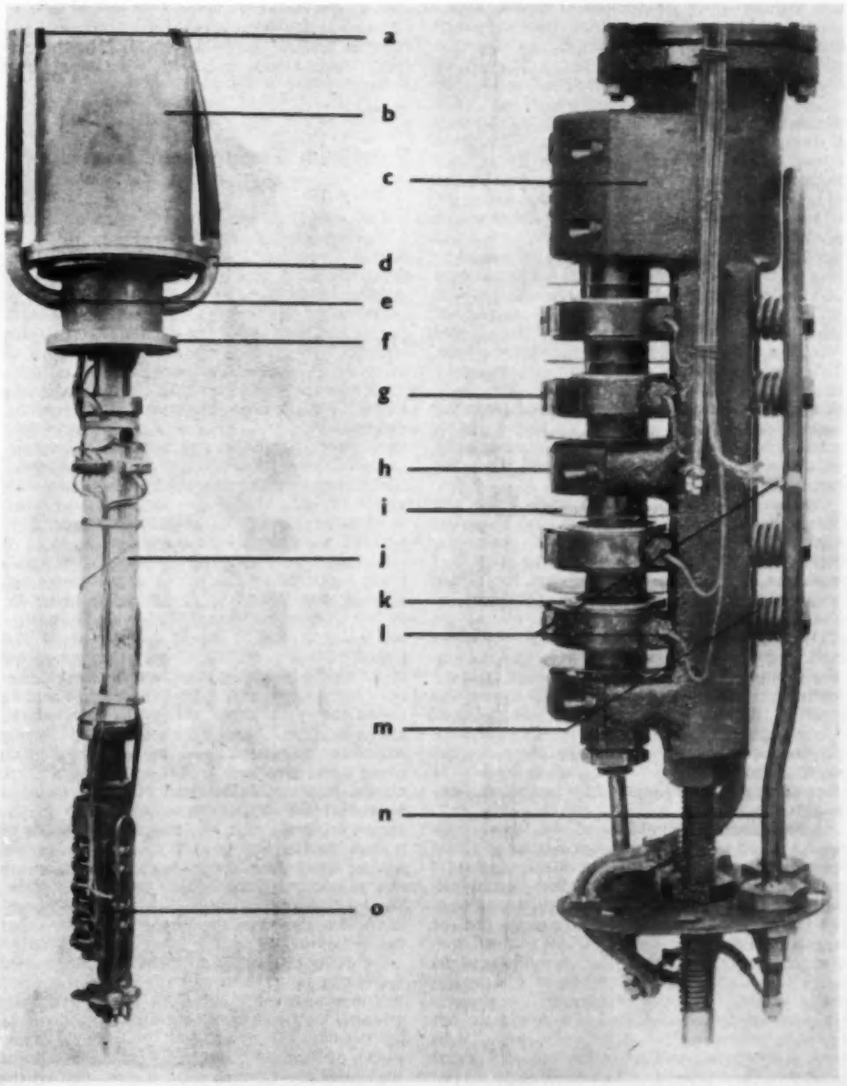
The " Setra " rig, illustrated here, consists of an electric motor contained in the housing *b* driving the bearing and gearbox test assembly *o* by means of a drive shaft inside the extension tube *j*. Carbon dioxide passes down to the bottom of the test assembly by means of the supply tube *a* and returns through the conduits *d* and *e* which also contain power and instrumentation cables. The extension tube and test assembly fit inside an irradiation sample can which is sealed by the adaptor *f*.

On the right of the first illustration there is an enlarged view of the test assembly *o* ; it shows a test gearbox *c*, which drives a shaft at 900 r.p.m., carrying four test bearings contained in housings *g* which are loaded by means of " screw-down " springs *m* attached to the housings. The bearings are fitted with seals *k*, but in the event of any slight leakage, seepage throwers *i* are fitted to the drive shaft to prevent contamination of bearings underneath. The temperature of the test assembly can be adjusted by means of heaters *n* up to 250 deg. Cent. and the test bearing and ambient temperatures recorded by means of thermocouples *l*. There are three sealed slave bearings, one inside the gearbox housing *c* and two in housings *h*.

The whole apparatus, enclosed in a cylindrical casing (not shown in the illustration), is submerged and located at the bottom of the fuel element irradiation pond, and spent fuel elements from the " Dido " and " Pluto " reactors are arranged around the bottom of the irradiation sample can to provide the desired gamma flux. The test assembly is at the bottom of the sample can, where a high gamma flux of up to 3 megarads per hour can be obtained.

Failure of a grease is denoted by a rise in temperature, but there is also an overload " cut-out " on the motor in the event of excessive grease stiffening before temperature rise.

The test rig has been in operation since June and lubricants have been tested to radiation doses exceeding 1000 megarads.



" Setra " (submerged, elevated temperature, irradiation apparatus) shown without its housing. A motor *(b)* drives through the drive shaft *(j)* the bearing and gearbox assembly *(o)*. On the right is an enlarged view of the test assembly showing the gearbox casing *(c)* and test bearing housings *(g)*

SHORTER REPORTS

Electrification Conference Banquet

DELEGATES to the British Railways Electrification Conference last week were entertained at a banquet given at Guildhall, London, on October 7 by The British Electrical and Allied Manufacturers' Association, and the Locomotive and Allied Manufacturers' Association of Great Britain. The banquet was attended by the Lord Mayor, Sir Edmund Stockdale.

Proposing the toast of "International Co-operation," the Rt. Hon. Reginald Maudling, President of the Board of Trade, said that national barriers round our economies were becoming more and more out of date. We had seen the development in Europe of the Six and the Seven, both of which, he thought, were contributions to lowering the barriers to trade between nations. It was hoped the two groups could get together and that every barrier to trade in Western Europe could be swept away. We owed a debt to the less developed countries in the world to help them catch up with us in standards of production and living. This involved technical assistance and technical training, without which no amount of capital assistance would be of value. In looking at the problems of international trade and the development of the less-developed countries, it seemed to him that the railway industry had been a true leader. For technical and human reasons, railwaymen throughout the world had led the way in trying to conquer national barriers. The spirit of comradeship between railwaymen throughout the world had always been one of the great glories of their industry. Railways must play an immensely important part in the development of the less industrial countries. He hoped the electrification conference would be of considerable value both to international understanding and to the flow of trade, and he thought it would be a genuine contribution to the spread of knowledge. We had come later than some countries into this field of railway electrification. This was not always a disadvantage, because we might profit from others' mistakes. We could now show how much we had learned from the experience of others, and that we had a certain amount to teach other people from a programme of electrification which, he believed, was the largest in the world.

Monsieur Dargeou, Vice-President of the International Union of Railways and Director-General of the French National Railways, replied to the toast. Railways, he said, had been the first means of transport for which national frontiers had become too narrow. To-day the 50-cycle a.c. scheme was one of the main contributions to international co-operation, and he was glad to see a conference such as this promoting the success of the system in many countries. Joint use of modern techniques was part of the programme of the International Union of Railways, which intended to continue this essential work, maintaining close contact with all countries and drawing upon the best of the schemes put forward by scientists and engineers.

Lord Chandos, President of the Locomotive and Allied Manufacturers' Association of Great Britain, proposing "Railway Modernisation," said he believed we were the first country to have an a.c. grid, and the a.c. traction system seemed a natural extension to the grid. To the experience they had gained of electrification in many parts of the world, British manufacturers were now adding the experience of the present huge scheme. They had carried out projects in parts of the world differing widely from our own in climate and traffic conditions. Theirs was a flourishing and adaptable industry which could serve anyone. In concluding, Lord Chandos paid tribute to Mr. Warder, Chief Electrical Engineer of the British Transport Commission. It had been his responsibility to make the recommendation concerning the a.c. system, and he had displayed a single-mindedness and enthusiasm which had won the respect of all.

Sir Brian Robertson, Chairman of the British Transport Commission, said in his reply that although the ravages of war in this country had fallen to some extent on the railways, they had not done so nearly enough, with the result that in London there were still standing stations which were monuments to the dirty habits of the steam engine and the rather curious aesthetic tastes of our forebears. They would dearly love to set about them, but they must deal with first things first and they must pay more attention to those things which directly affected services, such as traction and the track on which it ran.

Sir Leslie Gamage, President of The British Electrical and Allied Manufacturers' Association, made the closing speech. He expressed the gratitude of all to Sir Brian Robertson and his colleagues for their inspiration in arranging the convention and giving them such a splendid shop window to show the whole world their goods and what they could do. He hoped all their guests would acquire a livelier respect and admiration for what they were doing in their factories and on the railways, which he thought would bear comparison with what was being done anywhere in the world.

Petroleum Equipment Manufacturers Annual Dinner

THE annual dinner of the Council of British Manufacturers of Petroleum Equipment was held at Grosvenor House, London, on Wednesday, October 5, and was attended by over 1500 members and their guests. Mr. J. M. Storey, the chairman of the Council, presided, and in proposing the toast of "The Guests" opened his remarks by regretting that it was impossible to make the presentation to Mr. Bonstow to mark his retirement from the Council's service, owing to Mr. Bonstow being indisposed. Membership, the chairman was pleased to announce, had risen from 420 to 530, and that liberal interpretation of the Articles of the Council now allowed contracting engineers to become members. He also mentioned that orders which had dropped in value from the level of £134 million in 1957 to £117 millions in 1959 showed some signs of recovering lost ground. Another statement made was that an analysis of the 1959 returns showed that 35 per cent of orders were for delivery within the United Kingdom, the remainder going abroad. The first customer of The British Oil Equipment Credit Company was stated to be Petroleos Mexicanos and the chairman was hopeful that further business would be transacted with other countries from whom enquiries had been received. Mr. Storey remarked that more and more nations were living upon long-term credits and thought there should be a reconsideration of credit facilities to enable the smaller firms to engage in the export business. He also proposed the issue of a multi-lingual Board of Trade Export Journal having advertising space available at a cheap rate to encourage the smaller firms to advertise. Sir John Wrightson, Bt., in his reply, strongly advocated the renaming of the Council so that the initial letters would form an abbreviation more easily committed to memory. He praised the setting up of the credit company but warned that long-term credit coupled with indiscriminate granting of facilities would not be a panacea for the cure of export ills. The pattern of the world oil industry is changing, continued Sir John, and the Council must adjust itself to the new pattern and so fashion its policies that old customers are retained and new ones acquired. Increasing consumption of oil tended to make the interests of producing countries and distributors coincide and he thought that future hopes depended upon political, industrial and commercial unity of purpose.

Mechanised Foundry

A COMPREHENSIVE programme of modernisation and mechanisation has been in progress for some time at the Derby foundry of the Qualcast, Ltd., group of companies which is responsible for supplying some 53,000,000 iron castings a year to the automobile, domestic appliance, transport equipment, machine tool and other industries. The Derby foundry is producing over 1000 tons of castings a week in three main sections equipped for floor moulding, die casting and is a fully automatic plant. This automatic plant has a potential output of some 400 tons a week of grey iron castings weighing up to 60 lb and it was supplied by Badische Maschinenfabrik A.G. To comply with the requirements of the foundry this plant has had to be extensively modified and much of its control and other equipment rebuilt, and it is hoped that it will attain its full productive capacity within the next two or three months.

The ferrous die casting foundry equipped with Eaton plant is the only one of its kind in this country and is at present producing some 500 tons of castings a week. Each of the twelve machines installed consists essentially of a continuously rotating table round the side of which are spaced twelve dies. The table speed of rotation can be varied to give casting cycles between two minutes and six minutes. In the process the metal is poured from hand controlled ladles and has set by the time a die has reached a stripping station further round the table. At this stripping station the inner half of the die is drawn back by pneumatic cylinders and the casting removed by an operator. Each die whilst still in the open position then passes through an air blast where its surfaces are cleaned before it reaches a station where gas jets are automatically switched on to impinge on the casting surfaces and deposit a layer of soot, to facilitate stripping of the casting. If a hollow casting is being produced a core is inserted by an operator before the dies on the circuit are automatically closed immediately before reaching the pouring station.

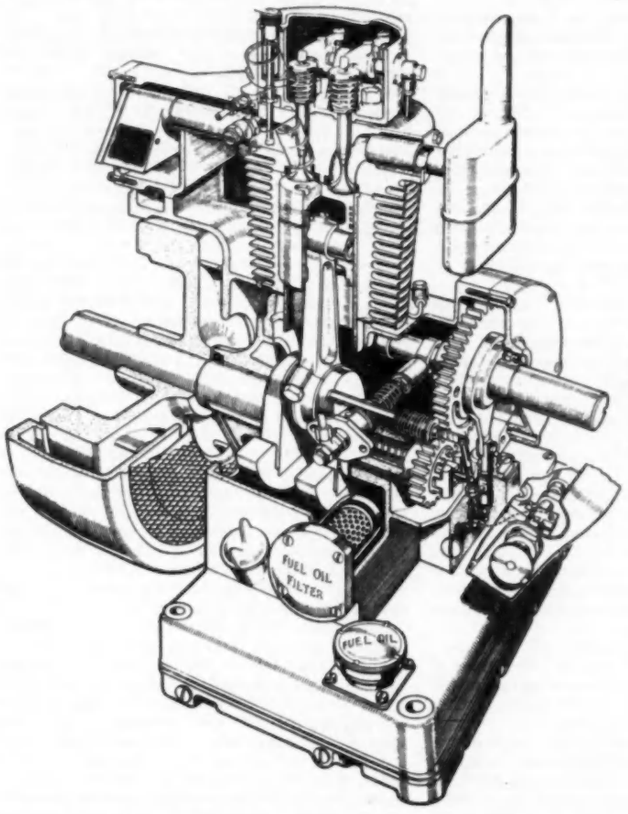
A particular advantage of this design of machine is that a variety of castings can be made on the same machine by fitting different dies on the one table. After they have cooled and the core sand and runners removed the die castings are heat-treated in continuous furnaces to remove the chilled skins which would be undesirable during subsequent machining processes. The castings are finally shot-blasted and fitted in a large section which adjoins the despatch department, at the end of the foundry. This form of die casting is claimed to produce a consistent casting with a particularly good grain structure free of holes and inclusions. Indication of the efficiency of this die casting method is the fact that last year of the 30,000,000 castings produced, customers' rejects averaged only 0·38 per cent. All of the dies used are made in a specially equipped shop adjoining the foundry and facilities are available for producing castings weighing up to 14 lb, using 16in by 18in dies having a maximum, cored, casting depth of 8in.

We are informed that plans are now in hand for a further 9 acres extension to the 80 acres of the Derby foundry and the installation of mechanised plant to increase its capacity by over 20 per cent. In addition to this foundry, the Qualcast group controls a number of other foundries producing various special iron and steel castings for all industries as well as the well-known range of lawn mowers.

Small High-Speed Diesel Engine

A COMPRESSION-IGNITION engine has been added to the range of small power units made by the Villiers Engineering Company, Ltd., Marston Road, Wolverhampton. Designated D-270, it has a single cylinder of 269 c.c., with a bore and stroke of 70mm, and is noteworthy as one of the few engines available for driving 3000 r.p.m. alternators; it does not, however, compete with the spark-ignition engines for automotive applications, since at that speed it develops only 4 h.p. (a brake mean effective pressure of 65 lb per square inch) and it weighs 160 lb. Although the makers have considerable experience with two-stroke engines of low power output, this cycle was rejected in this case because of the objection to lubricating oil in the exhaust when the engine is used for agriculture. The conception of the engine is, as our illustration shows, conventional, but instead of the cast-iron cylinder usually adopted by this firm an aluminium cylinder with a cast-iron liner is used in order to accommodate the highly uneven distribution of heat input with a peak opposite the Ricardo "Comet III" combustion chamber. Other unconventional details are that the fan is on the engine side of the cast-iron flywheel, allowing the engine to be directly coupled to the load, that the air cleaner is inside the cooling duct, and that a sump incorporating a fuel tank is available. The fuel system is unusual in that, instead of the C.A.V. pump being self-contained, it is built into the engine, the rack being journalled in the crankcase; the fuel system is self-priming, so that if the engine runs out of fuel nothing more is necessary than refilling and sustained cranking. For starting from cold in temperatures below 50 deg. Fah., lubricating oil is metered into the cylinder to seal the rings and raise the compression ratio. This is done by removing a small hollow plunger protruding through the rocker box cover and filling the hole thereby exposed with oil; replacing the plunger forces the oil into a pipe rising to the top of the hole (within the centre of the plunger) and thence to the inlet port. With this aid, starting is possible down to 20 deg. Fah.; cranking is effected by a crank handle fitting on the camshaft.

Equipment optionally available includes a 12V starter motor and dynamo, a clutch for the flywheel, reduction gears of ratios 3 and 6¼ for the flywheel end, a cooling air exhaust duct which also encloses the exhaust pipe, and a plastic housing to cover the entire power unit.



Engine with fuel tank incorporating sump and plunger pump for fuel and lubricating oil. Notice the simple pump for priming with oil before starting from cold

Glen Nevis Hydro-Electric Scheme

THE map below shows the North of Scotland Hydro-Electric Board's proposal for a water power scheme at Glen Nevis. The scheme has just been "published" and is the Board's constructional Scheme No. 37. Evidently special attention has been given to making the scheme as unobtrusive as possible in relation to the walks and views around Ben Nevis, and the Board's press statement heavily emphasises this aspect.

The scheme would have an annual output of 82,000,000kWh, and it is estimated that its construction would cost £4,200,000. A dam would be constructed across the head of a gorge situated about 2½ miles above Polldubh to form a reservoir about 1½ miles long. From thence the water would be led by tunnel to an underground power station situated close to the shore of Loch Leven which would discharge into the loch about 2 miles west of Kinlochleven. The power station would have a capacity of about 25MW and would operate under a maximum gross head of 940ft. Piped aqueducts and tunnels from some streams on the south and north sides of Glen Nevis, on the north side of Loch Leven and from the upper tributaries of the River Kiachnish, which flows to Loch Linnhe, are envisaged to supply the reservoir. After passing through a small generating set, compensation water would be released down the Water of Nevis at the end of the gorge below the dam. The storage which would be provided by the reservoir is stated to be "considerable" and therefore makes the scheme of special value to the Board.

Glen Nevis Hydro-Electric Scheme

The dam is envisaged as an arch structure 240ft in height, and the artist's impression which the Board has sent to us shows a central arch closing the deep gorge, carried by two massive concrete abutments for about the upper half of its depth. The dam is then completed by two wing-walls, closing off the relatively shallow part of the valley on each side of the arch, which appear to be lengths of gravity dam, and one of which incorporates a spillway. This dam would be the highest constructed by the Board, and the only arch dam of any size in the country. The Board states that "although 240ft in height only about a quarter [of the dam] would show above the gorge."

Modification of Two Motorway Schemes

THE Ministry of Transport has announced further progress with two major motorway proposals, both of which, for one reason or another, have had to be reconsidered.

Extension of the M.1 to Yorkshire.—The Minister has "announced the making of the scheme fixing the route of the second part of the London–Yorkshire Motorway." The scheme follows the draft line published in January this year (see THE ENGINEER, January 15, 1960, page 102) except for one minor modification. The next step will be to publish proposals for the alterations to side roads and private access; these proposals will be open to objection for a three-month period. Land negotiations and the detailed design of the scheme will also be put in hand, it is stated, and the date for starting construction will depend on the progress made with these remaining processes.

Birmingham–Preston Motorway.—The Minister's agents, the Lancashire County Council, has re-invited tenders for the construction of the 26 mile length of the Birmingham–Preston Motorway between Preston and Warrington. It is hoped to start construction early in 1961.

Invitations to tender for the two contracts covering this section were originally issued earlier this year, the Ministry states, but the average cost per mile in the lowest tenders proved higher than for sections of motorway elsewhere. The Minister arranged for a review to be carried out of the particulars of the contract documents to see if savings could be made without departing from the basic specification.

This review, which was undertaken jointly by officers of the Ministry, the Road Research Laboratory and the County Council, has now been completed, and agreement has been reached on modifications to the contract documents. These should make possible, it is stated, a substantial reduction in the cost of the finished motorway without any reduction in standards.

"To allow for the difficult soil conditions and the more than usually uncertain weather which may be met in Lancashire," the Minister has decided that the contract period shall be twenty-eight months. The Ministry's statement goes on to say that this period will include, in addition to the two summers which are more usual for projects of this size, the first half of a third summer. This decision is not without interest in relation to the comments on the motorway programme published in abstract on page 630. The construction of the remaining part of the motorway from Dunston (just north of Birmingham) to the Lancashire boundary will be phased to fit the new timetable, and it is intended that the whole motorway shall be completed in time for the main summer traffic of 1963.

SHORTER REPORTS *(Continued)*

Selset Reservoir

A LARGE impounding reservoir, built for the Tees Valley and Cleveland Water Board, was inaugurated on October 4. It is called Selset reservoir, and is on the River Lune, upstream of the Board's Grassholme reservoir. A net capacity of 2900 million gallons is available for supply from this reservoir, thus increasing the reliable yield of the Board's sources from 19·5 to 36·5 m.g.d.

The Selset scheme, the estimated cost of which is £8,075,151, includes, in addition to the Selset reservoir, new rapid gravity filters of a capacity of 16 m.g.d. under construction at Lartington to augment the existing slow sand filter beds which have a similar output ; a new electrically-driven pumping plant and rapid gravity filters at Broken Scar capable of dealing with up to 15 m.g.d.; a pumping station at Fighting Cocks which in addition to boosting in the zone fed direct from that source is also capable of transferring water to the Long Newton Zone ; a pumping station at the Long Newton reservoir for boosting ; over 50 miles of trunk mains ranging from 36in to 15in internal diameter ; and four service reservoirs.

The Selset reservoir itself accounts for about £3,000,000 of this total cost. It is formed by an embankment which has a maximum height of 130ft above the river bed. The maximum depth of the concrete-filled cut-off trench of the embankment is 126ft. The total length at road level is 3043ft and over 2,000,000 cubic yards of boulder clay were used to form the embankment. A typical cross section is illustrated.

Part of the valley floor under the central part of the dam consisted of between 7ft and 10ft of alluvial gravel over-lying about 15ft to 20ft of soft boulder clay, which in turn overlies sandstone and shale. In its original state the soft clay was considered incapable of supporting the dam, and as an alternative to removing it, which would have been extremely costly and would have delayed completion of the reservoir by at least a year, it was decided to strengthen it. This was achieved by the installation of over 4000 vertical sand drains, 18in in diameter up to 30ft deep, and at 10ft centres extending from the surface to sound boulder clay.

This installation of sand drains is considered to be the largest of its kind ever used in this country. However, the technique is now quite widespread and other examples have been described in this journal, namely the embankment at Chew Stoke (THE ENGINEER, June 17, 1955, page 851), Usk (THE ENGINEER, August 12, 1955, page 220) and more recently the very interesting example of the Derwent reservoir in County Durham, construction of which started this year (THE ENGINEER, February 12, 1960, page 266).

In constructing the Selset embankment material was obtained from borrow pits within the reservoir on both sides of the valley excavated by face shovels loading into trucks. The boulder clay was tipped on the embankment, spread by bulldozer, and compacted to the specified density by the constructional traffic and 15-ton smooth rollers. The effect of rain on the material was very pronounced and in the wet summers of 1957 and 1958 progress was much retarded.

Because of the low rate of dissipation of the pore water pressure in the boulder clay, drainage layers were included at 15ft vertical centres to shorten the drainage path, thereby accelerating the rate of dissipation of pore pressure and hence the rate of consolidation. Groups of piezometers were installed in the foundation and in the embankment to measure the pore pressures as the height of the embankment advanced and thus to observe the efficiency of the drainage measures.

The diversion tunnel used for carrying the river during the construction of the embankment is 1400ft long and 17ft in diameter, and most of it was formed with cast iron segments upstream of the dam centre line and precast concrete segments on the downstream side. This tunnel accommodates the two 36in diameter supply pipes and the 36in diameter scour pipe. The latter discharges into the pool formed below the dam, whilst the supply pipes are capable of carrying water to Grassholme reservoir, via the pool, or to Hury reservoir in the adjoining Balder Valley via the existing Grassholme-Hury tunnel. The valves for controlling the supply are at the tailbay end of the diversion tunnel. The valve house at the top of the embankment controls draw-off from the reservoir.

The overflow consists of a side weir 360ft long, discharging into a 1800ft long spillway channel leading to the pool, the detailed design of which entailed hydraulic model investigations at City and Guilds (Engineering) College.

The consulting engineers for the Selset reservoir are Messrs. Edward Sandeman, Kennard and Partners ; the main contractor is Balfour, Beatty and Co., Ltd. A second dam 155ft high which will form a reservoir of 4000 m.g. capacity is soon to be built in the adjacent Balder Valley, under the consultant's direction. This dam, together with increased powers of abstraction, will raise the figure for reliable yield quoted earlier (both figures exclude a source of 9 m.g.d. at Low Worsall), to 65 m.g.d. Other works in the overall scheme are under the direction of the Tees Valley and Cleveland Water Board's chief engineer, Mr. T. S. R. Winter, M.I.C.E.

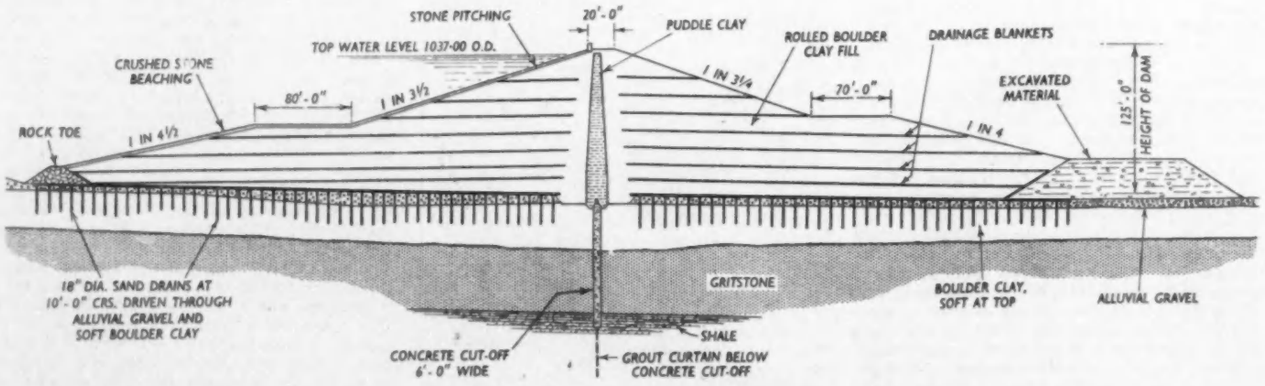
"Courier" Communications Satellite

A DELAYED repeater satellite, "Courier 1B," was launched from Cape Canaveral, Florida, on October 4 and went into orbit at a height of 650 miles. The launching vehicle was a "Thor-Able Star" rocket. This form of communications satellite records and stores signals from a ground station while it is in "view" and later retransmits them on coming into "view" of another ground station to which the messages are addressed. Reception, storing and retransmission of previously-stored messages proceed simultaneously. The satellite is a 51in sphere weighing 500 lb.

Some details of the "Courier" project were given in a paper read by Mr. L. Pollack of the I.T.T. Laboratories at the recent general assembly in London of the International Scientific Radio Union (U.R.S.I.). The satellite normally transmits a low-power v.h.f. beacon signal for tracking purposes. When it comes within range of a ground station, a coded command from the ground activates the u.h.f. transmitter and receivers in the satellite. The four satellite transmitters, working in the 1700–2400 Mc/s band, transmit horizontally and vertically polarised signals on two frequencies. At the ground receiver the four transmissions are combined before detection at i.f. The two base band outputs are further combined to give a four-fold diversity system which will resist signal variations caused by satellite tumbling and nulls in the antenna pattern. The 1kW ground transmitter, through orthogonal illumination of a 28ft parabolic reflector, directs a circularly-polarised signal to the satellite receiver. The 4W satellite transmitter output and the ground receiving system noise figure of 3dB should yield a signal-to-noise ratio of better than 21dB at the maximum slant range of 2700 miles.

In the present experiments signals are being exchanged between stations in Puerto Rico and New Jersey. Each ground station can accommodate the output of twenty teleprinters operating continuously at 100 words per minute. Messages are recorded on magnetic tape at a speed of about 1·6in per second during the time the satellite is not in view. When it comes into view the recorded signal is transmitted at high speed, 60in per second, and is tape-recorded in the satellite, to be played back later to the next ground station. Here the messages are recorded on punched paper tape for eventual decoding by teleprinter.

While the delayed repeater system is economic for digital transmissions where delays as much as twelve hours can be tolerated, Mr. Pollack considered that synchronous orbit satellite repeaters would eventually prove economic as commercial telephony relays, and his paper outlined a scheme for a three-satellite system operating in the 2000–4000 Mc/s band in which satellites would be position- and attitude-controlled above the mid-Atlantic, mid-Pacific and Indian Oceans. The Atlantic satellite would link Western Europe, Africa, all South America and the eastern United States. This satellite would handle the greatest traffic, with a total of 960 duplex voice channels. The allocation of channels to the other ten satellites would be on the basis of linking small as well as large countries whose growth in communications had been impeded by natural barriers.



Typical cross section of Selset embankment showing sand drains and drainage blankets

Carbon Stack for Vehicle Control

BATTERY vehicles of the "Electruk Rider" series manufactured by T. H. Lewis, Ltd., Station Estate, Balmoral Road, Watford, Herts, are now available with a carbon stack controller, giving stepless acceleration at a controlled rate. The controller, made by the Electro Dynamic Construction Company, Ltd, is hydraulically operated. The driver's control pedal operates a piston in a master cylinder which is connected to a slave cylinder on top of the controller as shown in the drawing. On depression of the pedal, initial movement of the slave cylinder piston rod releases a switch in which one pair of contacts then closes to energise the line contactor (provided that forward or reverse running has already been selected) and start the vehicle with the carbon stack resistance at its maximum. The rod operates a lever, one end of which is shaped to bear against the end of the carbon stack unit so that pressure on the stack is smoothly increased as the rod continues its travel. In this way the resistance in series with the motor is reduced progressively, the rate being controlled by an adjustable dashpot time delay device connected to the other end of the lever, which can be set to vary the compression period from one to seven seconds. Controllers are normally sent out from the works set for 2½ seconds.

At the end of its travel the slave cylinder piston rod closes a further switch which short-circuits the carbon stack and gives the full speed of the vehicle. In normal operation the control pedal is fully depressed on starting, but slight momentary pressures may be applied for "inching" when manoeuvring. Adequate ventilation is provided to dissipate the heat generated in the carbon stack during the normal accelerating period, and the controller is installed in the vehicle so as to take advantage of the air flow available while running. It is not intended that the vehicle should be driven with the controller stack in circuit. On release of the pedal the controller is returned rapidly to the "off" condition by a spring. The controller measures 18in long by 7in wide by 13in high overall, and weighs 40 lb.

A relay interlock circuit is arranged to open the line contactor if the reverse handle is moved from "forward" to "reverse" or *vice versa* while the vehicle is in motion. This circuit is completed through contacts in the line contactor operating switch which are closed when the controller is "off" (the contacts in the same switch which make the circuit to the contactor operating coil then being open.) Movement of the reverser handle in either direction energises a relay, one contact of which maintains the circuit through the relay coil after the line contactor switch contacts have closed, while the other is in the circuit to the line contactor coil. In these conditions, movement of the reverser de-energises the relay and opens the line contactor, which cannot be re-closed until the driver has released the control pedal and operated it again.

The "Electruk Rider" vehicles to which this control can be fitted are 25 cwt trucks available with alternative bodies for dairy or grocery deliveries or other purposes. They are powered by a 32V Tudor battery and have a speed on the level of 10 m.p.h. Range per charge is 10 miles in average conditions with the standard battery or 16 miles with an oversize battery, and the gradient capacity is 1in 6 (1 in 4 for short distances.)

[Reply Card No. E6431]

High-Speed Bag Packer

A NEW high-speed packer for calico, jute and open-topped paper bags in the range 50 lb to 150 lb has been placed on the market by Thomas Robinson and Son, Ltd., Rochdale. It is electro-hydraulically operated, and is normally installed on two floors, the weigher being mounted on the floor above the bag packing and serving section.

To set the machine in operation five manual switches, controlling the weigher, packing auger, hydraulic pump, transporter and sewing heads are switched on, together with the weigher feed system. The weigher is fed by a geared motor and feed mechanism, which operates until 80 per cent of the materials being weighed is in the weigh hopper; the feed is then reduced automatically to a trickle until the weighing is complete, when it cuts off and a sign "weigher full" is illuminated on the control panel on the floor below. An operator, having placed a bag on the packing tube, then depresses a foot pedal, which causes the bag to be clamped hydraulically by means of a forked clamp mounted on a vertical ram. This clamp raises the bag up the packing tube below the weigher, and so ensures that weighed material is packed right into the bottom corners of the bag. The density of packing depends on the rate at which the clamping gear lowers the bag, and a valve on the control panel enables this rate to be varied.

Within the packing tube, which is easily changeable to suit different sizes of bag, is a continuous packing auger running in ball bearings and driven through a hydraulic coupling by a 15 h.p. electric motor. This coupling slips at peak load, and thus prevents bursting of the bag. It also cushions the first surge of material from the weigher. Actual packing or "lying" of the material is by means of an impeller with two wings of aerofoil section, mounted at the end of the auger. This ensures that no unpacked area exists under the auger spindle end, and that the density is uniform.

When the bag is full, it is lowered to a V-rope transporter, which carries it to the sewing machine. The complete transporter is mounted on three legs, and can be raised or lowered hydraulically by a central hydraulic ram controlled by a small hand pump to suit bags of different lengths. The transporter does not run continuously, but is started by the machine operator by pressure on a double-action switch, just before the bag is lowered from the packing tube. Further pressure on this switch brings the sewing machine into operation.

There are two sewing machines, with independent 1¼ h.p. motors, mounted on a ball thrust turret with a quick adjustment lever. The machines are arranged back-to-back on the turret so that broken needles can be replaced from the back of the packer without interfering with its operation, simply by swinging the turret. A power plug and manual switch are provided so that the spare sewing machine can be tested without loss of production.

Electrical interlocking prevents the packer from operating if the weigher is not full; if the weigher pan should remain open; if the main motor stops; or if the forked clamp is not seated correctly at the bottom of its stroke when the operator commences. As a safety precaution the operator is provided with a red foot-switch adjacent to the packing cycle switch. Operation of this switch returns the clamping gear to its starting position from any point in its stroke, and opens the clamps immediately.

Packing speeds achieved on recent tests with flour are eight bags per minute with 70 lb bags and six per minute with 140 lb bags.

[Reply Card No. E6432]

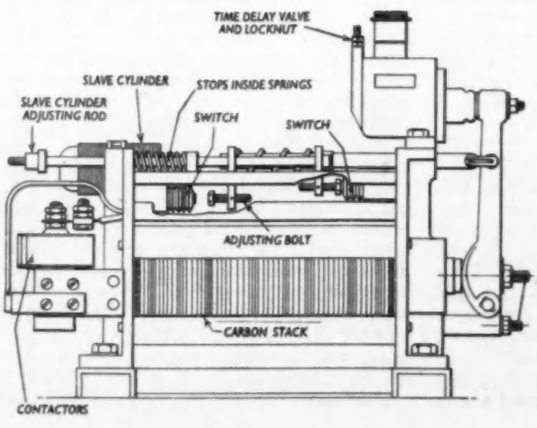
Getting the Best Out of Coal

THE Construction Engineering Association is organising a conference "Getting the Best Out of Coal" which is to be held at Harrogate on November 8 and 9 next. This conference, to be held under the chairmanship of Mr. N. A. McNeill, will examine from both the technical and the economic aspects the choice of coal allied to the selection, operation and maintenance of equipment for boiler plant and industrial furnaces and kilns.

The opening address of the conference will be given by Dr. C. M. Crawley, chief scientist to the Ministry of Power, and this will be followed by a session dealing with choosing the right coal. Mr. A. H. Slade of the National Coal Board will then deal with the selection of coal and what the new N.C.B. sales service has to offer to the consumer; Mr. R. C. Tomlinson, also of the N.C.B., will then explain the procedures for sampling and their application in ensuring a consistent grade of fuel for each particular purpose. These two addresses will be followed by open discussion.

The session on fuel-using appliances has been divided into two parallel studies embracing (*a*) boiler plant and (*b*) industrial furnaces and kilns, and delegates will be able to choose the line of study in which their interest lies. One division will hear a talk on boiler plant by Mr. F. L. Griffiths; the other division will be addressed by Mr. E. Rowden on kilns in the heavy clay and refractory industries; and Mr. R. Brown will talk on industrial furnaces. Following the talks each division will split for group discussions, after which there will be a general discussion for all delegates.

The third session of the conference will be devoted to choosing new plant or extensions to existing plant and will again be split into two divisions—the boiler division being addressed by Mr. J. E. H. Moore, and that concerned with industrial furnaces and kilns by Mr. J. J. Whiteheart. All delegates will combine for the final session to hear an address on new development in boiler plant by Mr. G. G. Thurlow, of British Coal Utilisation Research Association; and an address on new developments in industrial furnaces and kilns by Dr. P. L. Start, of the Department of Fuel Technology and Chemical Engineering, Sheffield University.



Operating mechanism of carbon stack controller

Launches and Trial Trips

NOTTS FOREST, trawler; built by Goole Shipbuilding and Repairing Company, Ltd. for Consolidated Fisheries, Ltd.; length 137ft, breadth 28ft, depth 14ft 3in, speed 12¼ knots; Mirrlees K.55.D.M.S.8 diesel engine, 1120 b.h.p. Trial, August 30.

RIGEL, oil tanker; built by the Chantiers de l'Atlantique (Penhoët-Loire) for the Compagnie Navale des Petroles; length between perpendiculars 704ft 5in, breadth moulded 102ft 1in, depth 50ft 6in, draught loaded 37ft 9in, displacement loaded 61,960 tons, deadweight 47,835 tons, service speed 16·4 knots; Penhoët-Burmeister and Wain, Mark 1274 VTBF 160, single-acting, two-stroke, twelve-cylinder, supercharged diesel engine arranged to burn heavy fuel, 15,000 b.h.p. at 115 r.p.m. Trial, August.

VOSGES, shelter deck cargo ship; built by the Chantiers Navals de la Ciotat for the Messageries Maritimes; length between perpendiculars 478ft 10in, breadth moulded 64ft 7in, depth to shelter deck 39ft 5in, draught loaded 26ft 2in, deadweight 9300 tons, displacement 15,000 tons, service speed 19·5 knots; five holds, three continuous decks, eight watertight compartments, bipod masts, one 60-ton, one 30-ton, four 10-ton and ten 5-ton derricks, sixteen 5-ton electric winches; three 300kW diesel-driven generators, Burmeister-Wain 1174 VTBF 160, eleven cylinders, 740mm bore by 1600mm stroke, 13,700 b.h.p. at 115 r.p.m. Trial, August.

INDUSTRIAL NEWS

Agricultural Machinery Exports

The latest figures issued by the Agricultural Engineers Association show that the industry's exports for the first two-thirds of this year have established a record. Farm machinery exports are at present 13½ per cent greater than at the same time last year whilst exports of tractors are 35 per cent greater.

The highlight in the agricultural industry's export pattern, the association points out, is that all member countries of the European Common Market have so far this year bought more of the industry's products than they did last year. Purchases by these countries show an increase of 35 per cent over the first two-thirds of 1959.

In the first two-thirds of 1960 the industry has exported 100,655 complete new tractors, only 15,000 fewer than the record figure for the whole of last year. The value of the agricultural industry's exports so far this year has increased by more than £20,000,000, and is now running at an annual rate of over £30 million.

Institute of Personnel Management

Addressing the annual conference of the Institute of Personnel Management at Harrogate last Friday Mr. John Hare, Minister of Labour, described the role of the Government in the field of industrial relations. Our traditional system that wages and conditions of employment should be settled by free negotiations between the organisations representing employers and workers called for the Government to " hold the ring," he said, between the two parties and to ensure that neither side was put to a disadvantage. This system was on the whole successful, said Mr. Hare, for in the twelve months from June, 1959, to June, 1960, more than 300 important claims for increased wages or shorter hours covering practically the whole of industry were settled peacefully while less than ten resulted in disputes which led to strikes.

Commenting on the variation between the strike records of different industries, Mr. Hare said that shipbuilding and the motor car industry were examples where strikes were clearly a much more serious problem than in most industries. It was encouraging, he added, that joint talks were taking place about industrial relations in the shipbuilding and ship-repairing industry on a sub-committee of the Shipbuilding Advisory Committee under the chairmanship of the Ministry of Transport. But referring to the complexity and variety of the industrial relations problems of the motor manufacturing industry, the Minister said he had been struck by the fact that no formal joint discussion on how to tackle the problems had taken place between leaders of the two sides. It may be, he said, that one of the difficulties stemmed from the fact that motor manufacturing was not a clear-cut entity like most other manufacturing industries but had ramifications affecting other branches of the engineering industry. Could not the problem be tackled by the employers and trade union leaders concerned in the engineering industry as one affecting a very substantial section of their industry, he asked.

The Ministry of Labour, said Mr. Hare, had for some time operated an advisory service on personnel management staffed by personnel management advisers, whose main job had been to collect and spread information designed to improve labour-management relations and employment policies. On the other hand, he continued, the general work of studying and reporting disputes, giving advice about negotiating machinery and arbitration facilities, and, when appropriate, attempting conciliation, had been done by the Ministry's conciliation officers. It was now proposed, the Minister said, to integrate those two types of work and give them to special industrial relations officers.

In summing up, Mr. Hare said he would describe the present problems of industrial relations as being principally problems for industry itself to solve. For the trade unions there was the problem of securing closer unity and understanding between the leadership and rank and file. For employers there was the problem of keeping abreast of modern developments, both in conditions of employment and in progressive management ideas.

Railway Shopmen's Pay Claim

A meeting between leaders of the trade unions concerned and the British Transport Commission was held on Monday this week when agreement was reached on increases in the rates of pay of railway shopmen. The National Union of Railwaymen had, therefore, called off the railway strike which was due to start on October 17. The unions had previously suggested an increase of 12s. 6d. in addition to the 5 per cent already given, which would have brought the rate for the top grade of skilled worker in the railway shops up to £10 5s. a week, but the British Transport Commission had made an offer which would have meant a weekly rate of £10 0s. 6d. This offer was rejected by the N.U.R. which then announced that it was calling a strike of all its 330,000 members. The Confederation of Shipbuilding and Engineering Unions, on behalf of railway shopmen who are not members of the N.U.R., urged the union's executive on Monday to accept an improved figure suggested by the Commission during the week-end which would bring the basic rate of most of the skilled men up to £10 2s. a week, on the understanding that the increases should be made effective from January 11 of this year, that the same increase should be given to all fully skilled men and that certain grading anomalies should be examined.

On Monday evening, agreement on the lines proposed by the Confederation was reached, and it was announced that the grading anomalies would be examined by a joint committee which would report to the Railway Shopmen's National Council by the end of the year.

Gas Council

The annual report of the Gas Council for the year 1959–60 was published this week. During the year under review, the report says the gas industry had a deficit of £2,376,521 on a gross income of £389,100,000, compared with a deficit of £1,466,882 on a gross income of £389,600,000 in the year 1958–59. Total income from gas sales during the year was £224,900,000 compared with £225,600,000 for the previous year. Because of increased competition from fuel oil, income from the sales of coke and breeze was lower by £8,100,000 and totalled £80,200,000 ; total income from other products was £20,800,000, from the sale of appliances £45,400,000 and from other sources £17,800,000. Since vesting date, the Gas Council records, some £509,000,000 has been invested in fixed assets, of which £206,000,000 has been provided from depreciation. Capital investment approved by the Minister of Power for 1959–60 was £55,500,000, but actual expenditure was £47,600,000.

The total gas available was 2,821,000,000 therms. Sales during the year totalled 2,591,000,000 therms. Coal used during the year totalled 22,300,000 tons. Coke production amounted to 9,900,000 tons and breeze 2,500,000 tons. Coke sales totalled 8,400,000 tons and breeze 1,900,000 tons.

At the end of March, 1960, there were 126,970 people employed in the industry, the figure for the previous year being 132,576. The reduction, which has continued since 1952, is due, the report points out, to the closing of smaller and less economic works—thirty-five were closed during the year bringing the number of works in production on March 31, 1960, down to 428 compared with 1050 at vesting date—the introduction of modern plant with automatic control and a lower labour requirement, and more centralised organisation by the area boards. There was no general increase in wages or salaries during the year, but the working week for manual workers and maintenance craftsmen was reduced from forty-four to forty-two hours.

Education and training facilities have been further expanded, the report says, and during the year 197 students attended sandwich courses.

Employment

During August, the Ministry of Labour says, the number of people in civil employment is estimated to have increased by 117,000 to 23,779,000. There were increases in the number employed in nearly all sectors of industry, the largest being in the construction industry in which there was an increase of 21,000 bringing the total to 1,554,000. In the engineering and electrical goods group the number of people employed rose by 19,000 to 2,075,000, in the metal goods group there was an increase of 6000 bringing the total up to 556,000 and in the metal manufactures group the number employed rose by 5000 to 627,000. The number of people employed in the manufacture of vehicles increased by 5000 to 923,000. On the other hand, in the shipbuilding and marine engineering groups the number employed dropped by 1000 to 250,000 compared with a total of 264,000 at the end of August, 1959.

The number of operatives working overtime in manufacturing industries in the week ended August 27 was 1,713,000, which was 60,000 less than at the end of May. In the same week, the Ministry reports 31,000 operatives were working short-time in the manufacturing industries, this was 10,000 more than at the end of July. The average number of hours of overtime worked was eight, and the average number of hours lost by each operative on short-time was nine and a half.

PERSONAL AND BUSINESS

Appointments

MR. NEIL WATES has been appointed to the board of directors of Wates, Ltd.

MR. J. V. SHELDON has been appointed sales director of Simplifix Couplings, Ltd.

MR. W. HANLON has been appointed a director of Clarke, Chapman and Co., Ltd.

MISS A. M. LANE, has been appointed administrative secretary of The Television Society.

MR. F. MILLER has been elected chairman of the North-West Region of the British Institute of Management.

The Electricity Council has appointed Mr. R. D. V. Roberts as industrial relations adviser to the Council.

MR. J. R. M. WHITEHORN has been appointed deputy overseas director of the Federation of British Industries.

MR. R. E. HUFFAM has been re-elected for a third term of office as president of the British Standards Institution.

A. REYROLLE AND CO., Ltd., announces that Mr. J. F. Bird, M.I.E.E., has been appointed the company's overseas manager.

MR. F. TURNER, manager of the locomotive division of John Fowler and Co. (Leeds), Ltd., has been appointed a local director.

THE TARMAC GROUP OF COMPANIES has announced the appointment of Mr. W. N. Cook as a director of T. G. Construction Company, Ltd.

MR. PETER B. HAMILTON has been appointed personal assistant to Mr. Charles W. Hayward, chairman of the Firth Cleveland Group.

METROPOLITON-CAMMELL CARRIAGE AND WAGON COMPANY, Ltd., announces that Sir Ralph B. Emerson M.I.C.E., has been appointed a director.

MR. P. A. M. CURRY has been appointed deputy to Mr. H. St. A. Malleson, head of the government and industrial valve division of Mullard, Ltd.

MR. J. C. REED, formerly sales engineer of Birmingham Aluminium Casting (1903), Company, Ltd., has been appointed sales manager of the company.

MR. J. S. BROUGH, M.I.Chem.E., M.I.Mech.E., has been appointed to the board of directors of Mono Pumps, Ltd., as assistant managing director.

DAVIDSON AND CO., Ltd., states that Mr. D. R. S. Turner, A.M.I.Mech.E., has been appointed a director and general manager with effect from December 1.

MR. ANGUS HUNKING, managing director of Westool, Ltd., has been elected to the board of the Warner Electric Brake and Clutch Company, Beloit, Wisconsin, U.S.A.

JAMES BOOTH ALUMINIUM, Ltd., has appointed Mr. Arthur W. Williams as chief technical representative in charge of the company's technical sales service department.

THE JUNIOR INSTITUTION OF ENGINEERS announces that Mr. Ernest Stanley Sellers, M.I.Chem.E., has accepted the invitation to be president of the Institution for 1960-61.

MR. FREDERICK POLLACK, A.M.I.Mech.E., has been elected chairman, and Mr. Geoffrey F. de. C. Sizer secretary, of the United Kingdom Section of the Standards Engineers Society.

BRITISH ROLLING MILLS, Ltd., states that Mr. J. F. Parker, chairman, Mr. G. St. J. Strutt and Mr. E. S. Parker have retired from the board. Mr. R. Ll. Lloyd has been appointed chairman.

BRITISH ERMETO CORPORATION, Ltd., has announced that the following additional directors have been appointed to its board : Mr. H. H. E. Beck, Mr. J. V. Sheldon, Mr. L. H. Sheffield and Mr. S. T. Wise.

THE MINISTRY OF TRANSPORT announces that Mr. A. H. Grainger, Mr. L. C. Hawkins, Mr. B. H. Harbour and Mr. Anthony Bull have been reappointed to be full-time members of the London Transport Executive.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., has announced the appointment of Mr. Jack Gibson as managing director of its South African subsidiary, the Consolidated Tool Company, S.A. (Pty.), Ltd., Johannesburg.

PROFESSOR B. BLEANEY, F.R.S., and DR. JAMES COOK, F.R.S., have been appointed members of the Council for Scientific and Industrial Research. A third member is yet to be appointed. They have succeeded Professor P. M. S. Blackett, F.R.S., Sir Eric Ashby and Mr. H. Douglass who have retired on completion of their period of service.

DOWTY GROUP, Ltd., announces that Mr. Lionel Harper, a director of Coventry Precision, Ltd., has been appointed vice chairman of the board. Mr. E. S. Gibbons, managing director of Designex, Ltd., has been appointed to the board of Coventry Precision, Ltd.

MR. ERNEST MARPLES, M.P., Minister of Transport, has appointed Mr. C. D. Buchanan, B.Sc., A.M.I.C.E. A.R.I.B.A., M.T.P.I., to be advisor on urban road planning in his department. Mr. Buchanan was previously a principal inspector (special inquiries) in the Ministry of Housing and Local Government. In the Ministry of Transport Mr. Buchanan " will undertake the study of the long term development of roads and traffic in urban areas and their influence on the urban environment."

MARRYAT AND SCOTT, Ltd., announces that Mr. L. W. Honey, Associate I.E.E., has been appointed to the board of Marryat and Scott Holdings, Ltd. Mr. L. J. Gooch, A.M.I.E.E., has been appointed to the board of Marryat and Place, Ltd. Mr. A. J. Bryant has been appointed secretary of Marryat and Scott, Ltd., on the retirement of Mr. R. Walker who remains secretary of Marryat and Scott Holdings, Ltd.

Business Announcements

US INDUSTRIES, INC. (GREAT BRITAIN), Ltd., New Bond Street House, 1-5, New Bond Street, London, W.1., is now acting as European representative for the Frick Company, Sawmill Division.

JOHN PEACE (STEEL AND TOOLS), Ltd., Algoma Works, Wellmeadow Street, Sheffield, 3, states that it has appointed Mr. James McMorris as its agent for the whole of Scotland for the sale of its files and tools.

SHEEPBRIDGE ENGINEERING, Ltd., Chesterfield, has purchased for cash the issued share capitals of Purfection Engineering Company (Coleshill), Ltd., and its associated company Station Engineering (Coleshill), Ltd.

CHARLES WINN AND CO., Ltd., Granville Street, Birmingham, 1, states that its north western area office is being moved from 132a, Stamford Street, Ashton-under-Lyne, to 202, Cavendish Street, Ashton-under-Lyne. The telephone number remains the same, Ashton 3875.

INDUSTRIAL INSTRUMENT SERVICES COMPANY, pyrometer instrument manufacturers and British agent for sales and technical service of the Wheelco Instrument Division of the Barber-Colman Company, Rockford, Illinois, U.S.A., has moved to larger premises at Elkington Street, Aston, Birmingham, 6 (telephone, Aston Cross 2771).

THE KEY ENGINEERING COMPANY, Ltd., Larkfield, near Maidstone, Kent, announces that Mr. I. K. Robson is to handle technical and sales inquiries for Key pitch fibre conduit and underfloor duct at 2, Caxton Street, Westminster, London, S.W.1., (telephone, Abbey 4860). The offices of the conduit and underfloor duct department were previously at Blackfriars House, E.C.4.

BRITISH OXYGEN GASES, Ltd., Spencer House, St. James's Place, London, S.W.1., states that its trading is to be carried on in the name of the parent company, the British Oxygen Company, Ltd., to which all assets were transferred with effect from October 1. Until December 31, however, the company will act as agent for the British Oxygen Company, Ltd., and invoicing will continue in its present name until that date.

ERICSSON TELEPHONES, Ltd., has announced that an agreement in principle had been reached with The Bendix Corporation in the United States, to form a jointly-owned company in England to manufacture and market high precision instruments and electronic devices. The new company, Bendix Ericsson U.K., Ltd., will be located in Nottingham and will acquire the instrument division of Ericsson Telephones, Ltd.

YORKSHIRE IMPERIAL METALS, Ltd., and IMPERIAL CHEMICAL INDUSTRIES, Ltd., have decided that it would be advantageous to combine their activities in the marketing of polythene tube. In consequence, it has been agreed that Yorkshire Imperial Metals, Ltd., should assume sole responsibility for marketing " Alkathene " polythene tube from October 3. The combined product of the two companies will be known as " Polyorc-Alkathene."

AMF, Ltd., a member of the American Machine and Foundry Company, International Group, has moved its headquarters to new premises at Melrose House, 4-6, Savile Row, London, W.1. The following appointments have been announced : Mr. Gordon Jackson has been appointed chairman, and Major-General G. D. G. Heyman and Mr. G. M. R. Lord become joint managing directors. New appointments to the board also include Mr. Adrian Legg, and Mr. S. McLennan, who becomes finance director of the company.

BRISTOL AEROJET, Ltd., Banwell, Somerset, and PERMALI, Ltd., Gloucester, announce that an agreement has been signed whereby the two companies will collaborate in the manufacture and selling of specialised tubular components. The agreement is concerned with tubular structures of helically wound glass-fibre rovings bonded with synthetic resin, and the arrangements for participation are that manufacture will be undertaken by Bristol Aerojet, selling will be undertaken by Permali, and design and development will be a joint responsibility.

HENRY SIMON, Ltd., 28, Dover Street, London, W.1, has announced that in association with the American Machine and Foundry Company of New York, a new company, Simon-AMF, Ltd., is being established in the United Kingdom to sell and install automatic bakery machinery and equipment. Manufacture is to begin shortly at the plant of Simon's wholly-owned subsidiary T. and T. Vicars, Ltd. The company is also joining with Henry Simon, Ltd., in the establishment of a Continental sales company, AMF-Simon International S.A., with headquarters in Geneva, Switzerland.

PRESSED STEEL COMPANY, Ltd., announces that it is forming a subsidiary company to be known as British Executive and General Aviation, Ltd. (Beagle), which will concentrate upon the design and manufacture of light aircraft for the home and export markets. To this end it is acquiring the whole of the share capital of Auster Aircraft, Ltd., and it is intended to continue the production and further development of the existing Auster range of light aircraft. At the same time, the Pressed Steel Company states, a technical and manufacturing liaison has been arranged with F. G. Miles, Ltd., of Shoreham Airport. This new group of companies is also entering into discussions with Rolls-Royce, Ltd., in connection with a series of Rolls-Royce power plants for this class of aircraft. Mr. M. A. H. Bellhouse, deputy chairman of Pressed Steel will be chairman of Beagle. Mr. J. R. Edwards, managing director of Pressed Steel, will be a member of its board. Mr. Peter G. Masefield, who has joined the board of Pressed Steel, will become managing director of Beagle, and chairman of Auster. Mr. F. Bates and the other executive directors will remain on the board of Auster, Mr. Bates becoming deputy chairman, and, at the same time, retaining his position as managing director. Mr. George H. Miles will be appointed technical director on a co-ordinating board, which is to be formed under the chairmanship of Mr. Masefield.

Contracts

HOLLAND AND HANNEN AND CUBITTS (GREAT BRITAIN), Ltd., is to build a major production plant for Pressed Steel Company, Ltd., in less than twelve months, to plans prepared by Harry W. Weedon and Partners, at a cost of £3,500,000. The plant, at Stratton St. Margaret, near Swindon, is the third stage of development on this site.

CONSTRUCTORS JOHN BROWN, Ltd., in association with MARCHON PRODUCTS, Ltd., Whitehaven, have been awarded contracts by Techmashimport, Moscow, totalling nearly £3,000,000, for the design, supply of equipment and the commissioning of two factories to manufacture raw materials for detergents. The design of these plants will be based on Marchon Products' " know-how." Constructors John Brown, Ltd., is a member of the John Brown Group and Marchon Products, Ltd., is a member of the Albright and Wilson Group.

FERRANTI, Ltd., has received an order for an " Orion " data processing system from the Beecham Group, Ltd, manufacturer of soft drinks, toilet and pharmaceutical products, food and confectionery. The installation, with its associated input, output and magnetic-tape data storage equipment, will cost approximately £300,000. Data will be filed on magnetic tape which will permit the files to be up-dated daily. Peripheral equipment will include six high-speed magnetic-tape units and fast line printers for data output.

CONTINENTAL AFFAIRS

by Our Continental Editor

I.A.E.A. General Conference

THE General Conference of the International Atomic Energy Agency held its fourth session in Vienna from September 20 to October 1. In his inaugural address, the Director-General, Mr. Sterling Cole, referred to the important role which the Agency would play in the development of nuclear energy, if its full potential were not only recognised but also utilised by governments. Among recommendations made by him, but not so far adopted, were the registration with the Agency of all international shipments of uranium, the automatic placement under Agency administration of international traffic in uranium, the application of Agency safeguards to the peacetime facilities of atomic countries, the granting of a discount or preference to the Agency in the price of Uranium-235, and Agency co-ordination of research efforts in nuclear fusion. The Agency now was in what had been termed a period of consolidation ; a term over which he felt some concern so soon after the initial period of exploration. The appearance of a desire for consolidation required an early decision whether or not to move forward. That decision could not be long delayed without exploration turning into inertia, and consolidation into retreat. The actual situation which had developed in atomic energy had of necessity somewhat changed their immediate aims and tasks. However the delay in the advent of competitive electric power from nuclear energy was not entirely devoid of some advantages, as it had given a needed respite of a few years in which to prepare for a full utilisation of nuclear power, with due regard for the protection of the safety and interests of the public and a sharing of the benefits not only amongst a few but all.

Many of I.A.E.A.'s current programmes, Mr. Cole continued, were specifically aimed at this regulatory or preparatory task. Soon they would have trained one thousand scientists and technicians from member states sorely in need of such personnel. They were making considerable progress toward the formulation and acceptance of international regulations and uniform practices in many important fields, such as the handling of radioisotopes in laboratories and elsewhere, the transport of radioactive materials, the disposal of radioactive wastes, the safety of research reactors and critical assemblies, the civil and public liability in cases of accidents involving land-based or seaborne reactors. They were investigating the difficulties and costs involved in obtaining insurance coverage for the foreign shipments of fuel elements. They were stimulating and supporting important research in many branches of nuclear science and through conferences, symposia and publications were engaged in an effective world-wide exchange of information. Missions to some thirty atomically less-developed countries had given general advice to provide a basis for realistic and orderly national atomic energy programmes and for the administrative and organisational framework necessary for such development ; specific minor projects had been started with Agency guidance in many countries. During the past year I.A.E.A. had held nine scientific meetings on a variety of technical subjects attended by over 2000 scientists from forty-one countries ; 400 fellowships had been granted to students from thirty-eight countries ; experts and atomic equipment had been made available in twenty-seven countries ; thirty-one scientific reports, bulletins, symposia and conference proceedings had been published, and the first issue of its thermonuclear journal would make its appearance shortly. A draft convention on stationary reactor liability had been prepared and that would soon be followed by one on ship reactor liability. It was expected that during the coming year international conferences would be convened to act upon these drafts. I.A.E.A. had drafted codes for the transport of isotopes and irradiated fuel elements which would soon find their way into law. After concentrated preparation and study by highly qualified experts, technical recommendations on waste disposal had been made and it was expected they would soon be implemented. The principles and procedures dealing with the extremely important and equally sensitive subject of safeguards were being placed before the Conference. Research in very modest proportion was under way.

The slenderness of the financial basis upon which all this had been achieved—which Mr. Cole suggested required urgently a decision by the governments with regard to the Agency's future course—was perhaps best illustrated by the discrepancy between the allocations from operational or voluntary funds requested by the Board for the second half of 1960, involving an anticipated sum of 400,000 dollars or more, and the actual total available, which was only 40,000 dollars. That example not only showed how far short resources fell of actual needs, but also highlighted the anomalous situation caused by having two budgets, the regular budget funded from assessed contributions, and the operational budget funded from voluntary pledges. Governments last year, without argument or controversy, simultaneously with the regular budget had approved an operational programme for fellowships, technical assistance and laboratory costing an aggregate of 1,500,000 dollars. The same governments, however, who approved the programme of action later failed to support it fully financially, since less than 1,000,000 dollars had been pledged to the 1960 general fund for those purposes, half of which had come from a single country. The result had been that the resources of the Agency made possible under the regular budget, planned to support also an operational programme of a determined level, were actually not utilised to their full potential. That, in addition to falling far short of fulfilling urgent needs of member states, amounted to an uneconomic use of international resources and illustrated the difficulty of basing an operational programme entirely on voluntary contributions.

He could not stress that point too much at a time when the General Conference was being asked to establish a slightly higher target for the general fund for 1961, 1,800,000 dollars, which incidentally was a figure considerably less than what he considered essential to carry out the most immediate and urgent tasks. An approval of that target must carry the implication that member governments were prepared to provide the necessary resources to carry out the budgeted action programme which itself must gather momentum as atomic energy continued to offer new and varied possibilities, as membership increased, and as newly emerging independent states undoubtedly would rely heavily on international technical assistance.

The budget contained another striking feature which might appear anomalous : the high proportion of the cost of the I.A.E.A. governing bodies, the Conference and the Board of Governors, in relation to the regular budget, amounting to nearly 15 per cent. That percentage was considerably higher than in most of the specialised agencies of the United Nations, said Mr. Cole, and showed that some of the constitutional machinery provided in the Statute and developed in practice during the first years was clearly intended for larger operations and to some extent different aims than were later found to be realistic. It must be recognised that the machinery was created with a different type of operation in mind from the bulk of work which the Agency was now carrying out. It had been established on the assumption that the principal activity of the Agency would consist of the supply of substantial quantities of fissile materials under international safeguards. As the emphasis had shifted to more traditional technical assistance activities and purely scientific services, the statutory machinery might appear exceedingly complex to deal with these matters, and unless every effort were made to differentiate between policy issues and normal administration and implementation of approved programmes, there was a real danger that the constitutional machinery might actually act as a brake upon the execution of the programmes.

The Director-General went on to suggest that the Agency's financial predicament could be readily and adequately solved if each of the atomic countries were to turn over to the Agency some of their U-235 material now in weapon stockpiles. He seriously commended that course of action to the interested governments for it would mean relief of a great strain which was attached to their funding of the peaceful atom and it would achieve a measure of disarmament at one and the same time.

The decisions which would have to be taken in the near future did not, however, relate to financial support alone. They also had to do with the very place and role of the Agency in the international development of the peaceful uses of atomic energy.

Although the Agency was the first to be proposed to deal with atomic matters on a multi-national basis, Mr. Cole said he could not help but view with some concern the proliferation of other multi-national organisations which had been created for the same purposes but limited to geographical areas. Perhaps the creation of these organisations was advisable in order to deal with such atomic matters as are peculiar to a particular region, but he did believe that some co-ordination and delineation between the various efforts should be established. He was happy to report that good progress was already being made among the members of the United Nations which had been greatly facilitated by the reciprocal representation of the United Nations and the Agency at each other's headquarters and by careful consideration of the problem in the Administrative Committee on Co-ordination composed of the executive heads of each of the agencies related to the United Nations including their own, and chaired by the Secretary General.

While inter-secretariat arrangements among the members of the U.N. family had reached the point where functional divisions were recognised and duplication of effort was being avoided, there had still been instances where member governments had approved programmes in the governing bodies of other international organisations which might overlap with programmes already endorsed by their own General Conference.

The problem of co-ordination was therefore not limited to the U.N. family ; it became even more important with respect to regional intergovernmental organisations in the atomic energy field. Because of the cost and scientific complexity of atomic energy programmes it was natural that countries of the same area and common economic outlook should join together in order to undertake collectively what they might not be able to achieve separately. On the other hand

there were problems which transgressed regional boundaries and should be solved on a world-wide basis and in a uniform manner. Mr. Cole said he was referring especially to health and safety regulations, radiation protection measures and legal problems such as third party liability and the maritime aspects of atomic energy. If the resources spent by governments for international activities were to be applied in a rational and economic fashion, the work of the Agency in those fields should not be duplicated by similar activities of regional organisations.

The draft relationship agreement between the Agency and the European Nuclear Energy Agency, which the Conference was now asked to approve, constituted an important but only an initial step toward the establishment of close working relations and co-ordination of world-wide and regional effort.

The Director-General then briefly reviewed the preceding year's activities, referring to the growing programme of training and fellowships, and technical assistance to members through provision of experts and equipment. Two major scientific conferences, and other conferences and symposia had made a significant contribution to the interchange of scientific and technical knowledge. In the reactor field some heartening progress had been made during the past year. Some evidence of that was before the Conference in the document on nuclear power costs. Under the sponsorship of the Agency, for the first time an effort had been undertaken to clarify and harmonise the methods of nuclear power costing and thus facilitate an understanding and analysis of the economics of nuclear power. A pilot study jointly with Finland on the future development of nuclear power in that country had just been completed which should provide a guidance to others. Special reference should also be made to their Reactor Directory, the third volume of which was now in production and to the symposia and reports of the high-level meetings on heavy water lattices and computing codes. The Conference on Medium and Small Reactors recently concluded had proved encouragingly valuable and preparations for an important symposium this autumn on ship propulsion problems were well advanced.

Another activity of considerable importance was the safety evaluation of reactors. The first such evaluation had been carried out in Switzerland, and a similar request from the Netherlands was being met. A panel on the safe operations of critical assemblies and research reactors had drafted a manual which would be published soon. The radiation dosimetry project in Vinca was a particularly good example of multi-national scientific collaboration and solidarity. The far-reaching report of Mr. Brynielsson's panel on waste disposal into the sea was now before all member governments and he felt sure that it would encourage effective international action through the Agency, partly in conformity with suggestions that had been made to the Conference a year ago. A panel to make recommendations on how best to implement the Brynielsson findings was being organised, and a similar panel dealing with possible radioactive contamination of fresh water by atomic wastes would start its work late this year.

The Agency's supply function was for obvious reasons the one most affected by the unexpected tardiness in the development of nuclear power as an economic proposition. However, such requests as had been received were being met as expeditiously as possible. The arrangements with Finland for the supply of a research reactor with enriched uranium as fuel, and fuel for a critical assembly were almost completed.

Disappointment and criticism had been voiced at the fact that no further demand has been made upon the more than 5000kg of uranium-235 that had been made available to the Agency. It had to be remembered, however, that not more than approximately 300kg of uranium-235 contained in enriched uranium had so far moved in international trade since the dawn of the nuclear age. Without question, there would be a more active demand in the future and in the meantime they were gaining valuable experience in respect to procedures and agreements through modest pilot projects like the Finnish one.

Construction work at Seibersdorf was making progress and they were looking forward to starting scientific work at this first global international laboratory in the course of the coming year. Meanwhile, they had been able to carry out a good deal of laboratory work in the very limited facilities improvised in the basement of their temporary headquarters.

Some seventy research contracts had been awarded and were serving the dual purpose of supporting research work in institutions in member states and of filling gaps in nuclear research, particularly in the radiation and health and safety fields, including waste disposal.

In his conclusion, Mr. Sterling Cole referred to his previous suggestion that the internal organisation of the Secretariat could perhaps be improved and rationalised. He said that it seemed to him that the coming year would be the right time for consideration of such an attempt and he planned to present certain recommendations to the Board of Governors in connection with the budget presentation for the year 1962. The last phase of the first four-year cycle was not only an appropriate time for overhauling the administrative machinery ; it was also the time when the sincerity of their purpose and the firmness of their resolve would be tested. The coming year must see the beginning of the period of decision, a decision to expand and strengthen the Agency's activities.

Disposal of Radioactive Waste

In a round table discussion held on September 20, in conjunction with the Conference, Mr. Harry Brynielsson of Sweden, Mr. H. J. Dunster of the United Kingdom and Mr. Leslie Silverman of the United States, stressed the need for international registration of disposal operations in the sea, a task which they thought could be best carried out under the auspices of the International Atomic Energy Agency. Mr. Brynielsson, who served as chairman of the Agency's Panel of Experts on the Disposal of Radioactive Wastes into the Sea, recalled the main recommendations contained in the Panel's report which he hoped would become the basis of an international agreement or convention. So far as the sea disposals were concerned, he pointed out that the primary consideration should be that they should not limit man's harvest of marine products. While wastes of low activity could be dispersed into the sea, those of high or intermediate activity must be contained.

Mr. Silverman gave an account of United States practice in this field and explained the economic implications of disposal operations. He said there was no real problem in disposing of the waste produced in the normal operation of reactors ; the really difficult problem arose over the disposal of wastes produced in the course of the processing of irradiated nuclear fuel. In reply to a question, he disclosed that the present waste disposal costs in the United States amounted to between 1 dollar and 3 dollars per gallon of high-level waste. In order to obtain economic nuclear power—at about 8 mills per kilowatt—it would be necessary to keep the disposal costs down to 1 mill per kilowatt.

Mr. Dunster explained that the fundamental aim in waste disposal, to reduce as far as practicable the radiation dose to persons, could be achieved either by containing the wastes in shielded areas (the recommended method for high and intermediate activity wastes) or by dispersing them in the environment (the practicable procedure for low-level wastes). It was the wastes in the intermediate range that called for detailed individual investigation to decide how they should be dealt with. While containment and storing of all wastes would be an ideal solution, in view of the large and increasing quantities of wastes that were being produced, this was obviously not practicable. The practical answer therefore was to disperse the wastes except where it was necessary to confine and store them. However, it was reasonable to dilute and disperse the wastes only when this was safe, and the important question was to classify the wastes in accordance with their levels of activity. The paramount consideration must be the safeguarding of man and the question of costs must come next. Promising experiments had been going on to dispose of wastes in dry oil wells and saltmines. No country was known to have discharged high-level wastes into the sea or to have planned to do so. As to whether radioactive wastes could be disposed of in the upper regions of the atmosphere by means of rockets, this could be regarded as no more than a possibility. Apart from anything else one must also think of the very high cost of any such operation.

Development of Nuclear Power

A report " The Development of Nuclear Power—Review of Nuclear Power Costs " was submitted to the General Conference by the Board of Governors. The report concludes that under certain assumptions, generating costs with the large gas-cooled reactor in the United Kingdom will become competitive with conventional power in about 1966. Assuming that the improvements in the efficiency of conventional thermal power plants are levelling off, and under certain other conditions (such as an 80 per cent plant factor, 14 per cent annual capital charge, and constant price levels for fissile materials), the report estimates that by the end of the next decade nuclear power from large stations will become competitive where conventional fuel costs exceed 0·55 dollar per million B.Th.U. (2·2 dollars per million kilocalories).

Safeguards Against Military Uses of Materials

At a Plenary Meeting on September 30, the General Conference adopted a fifteen-power resolution on safeguards against diversion of Agency assistance to military purposes. The resolution, sponsored by Australia, Brazil, Canada, Greece, Italy, Japan, Netherlands, Nicaragua, Peru, Philippines, Portugal, Thailand, Turkey, United Kingdom and the United States, had been approved earlier by the Administrative and Legal Committee of the Conference by forty-four votes to fourteen, with five abstentions. The voting at the Plenary Meeting was forty-three in favour, nineteen against and two abstentions.

The resolution, among other things, notes that the procedures for the application of safeguards (submitted to the General Conference by the Board of Governors) shall guide the Board in negotiating agreements with member states, " having regard to the principle of non-discrimination between them." The operative part of the resolution takes note of the safeguards principles and procedures, and invites the Board, before giving effect to the safeguards document, to take into account the views expressed in the General Conference ; to include in its future annual reports an account of the application of these principles and procedures ; and to report to the General Conference at its Sixth Regular Session on the results of a general review of these principles and procedures.

When the report of the Administrative and Legal Committee on this question was taken up at the Plenary Meeting, Dr. Homi J. Bhabha of India reiterated his opposition to the fifteen-power resolution, which he described as " unsatisfactory in many ways." He said that the discussion in the Committee had revealed " a considerable and strong division of opinion " on the subject. He hoped that the Board of Governors would take note of the fact that the opponents of the resolution represented vast numbers of the world's population. Dr. Bhabha maintained that the resolution did not take any definite position on anything and merely took note of the safeguards principles and procedures, it did not say whether those should be followed or not.

Speaking for the Soviet Union, Professor Vasilij S. Emelyanov said that the sponsors of the fifteen-power resolution did not want to accept any kind of compromise ; they had not even allowed the draft resolution submitted by India and four other Asian countries to come to a vote in the Administrative and Legal Committee. Thus the countries which wielded the majority of votes did not think it necessary to consider the views of the minority, even when the minority represented a majority of population. Professor Emelyanov reiterated his view that the Agency safeguards would split states into two groups, one controlling the other.

Mr. Max H. Wershof, of Canada, said he was convinced that the Agency safeguards would not in any way cause the slightest harm to any of the member states. Referring to the views of the Soviet delegate, Mr. Wershof maintained that the arguments against the adoption of safeguards

CONTINENTAL AFFAIRS *(Continued)*

ran counter to the provisions of the Agency's Statute.

Mr. M. I. Michaels of the United Kingdom maintained that over a period of two years every attempt had been made to reach a compromise on the safeguards question. It was not claimed that the safeguards document was a consistent and logical whole ; it was a compromise and that was a point in its favour. The very fact that the fifteen-power resolution " took note " of the safeguards principles and procedures, which were meant for " guidance " in negotiation was the fullest reply to the accusation of any attempt at stringent control. Mr. Michaels also pointed out that a large number of the less developed countries had voted for the resolution in the Administrative and Legal Committee, while only five or six of the opponents could be regarded as less developed. The analysis of the voting in the Committee was thus a complete answer to the argument that the resolution was unacceptable to the less developed countries.

Mr. Karel Petrezelka of Czechoslovakia regretted that the five-power draft resolution had not been voted upon in the Committee, and that a final decision on a question of such great importance was being left to the Board of Governors. This should be a decision for the General Conference itself. He was convinced that the safeguards system would seriously affect the less developed countries of the world.

Speaking for the United States, Mr. Paul F. Foster said that the views expressed against the safeguards resolution had been heard over and over again. The sponsors of the resolution, he maintained, were open-minded and flexible in their approach. The United States was convinced that safeguards must be developed in an evolutionary manner and a beginning must be made now.

Earlier the General Conference unanimously approved two agreements for co-operation between the Agency and two inter-governmental organisations, namely, the European Nuclear Energy Agency (E.N.E.A.) of the O.E.E.C. and the Inter-American Nuclear Energy Commission (I.A.N.E.C.) of the Organisation of American States.

The agreement with E.N.E.A., already approved by the O.E.E.C. Council, enters into force immediately. In a statement to the General Conference welcoming the approval of the Agreement, Mr. J. L. Weinstein, Counsellor of E.N.E.A., emphasised that informal co-operation between the two Agencies had already taken place in important fields of mutual interest such as health and safety and legal liability.

The General Conference also adopted a resolution authorising the Board of Governors to invite inter-governmental organisations engaged in the peaceful uses of atomic energy to be represented at the next regular session of the Conference.

At its morning meeting the General Conference, pursuant to recommendations by its Programme, Technical and Budget Committee, also took the following actions :

Approved for the year 1961 I.A.E.A.'s regular budget of 6,168,000 dollars, its operational programme amounting to 1,800,000 dollars, and its working capital fund of 2,000,000 dollars.

Approved the Agency's provisional regulations for transport of radioactive materials and recommended them to Member States as a basis for relevant national regulations while urging the Agency to continue its work in the performance of research and the preparation of regulations, manuals and codes of practice relating to health and safety in the peaceful uses of nuclear energy.

Recommended that the Director-General study the possibility of selling I.A.E.A. publications in Member States for local currency.

Requested the Agency to study and report on the question of establishing an international centre for theoretical physics.

Urged the Agency's Board of Governors to continue to avail itself of the opportunity to consult the I.A.E.A.'s Scientific Advisory Committee on important matters of scientific and technical policy and requested the Agency's Director-General to review the procedure for keeping the Board informed on the decisions of the Scientific Advisory Committee.

Urged the Agency to arrange for an international exchange of abstracts of documents relating to the peaceful uses of atomic energy.

Requested the I.A.E.A. to explore the possibilities of co-operating in the field of radiation and neutron standards with the International Bureau of Weights and Measures and other international organisations acting in the field of standards and standardisation.

Requested the I.A.E.A. to continue to make nuclear power surveys in Member States at their request and to continue to collect and study data on nuclear power costs.

Voted to employ for technical assistance projects under the United Nations Expanded Programme certain funds provided to the Agency for administrative expenses related to that programme.

In its final actions of the morning session the Conference approved a schedule giving the scale of voluntary contributions by Member States for 1961 and recommended that the Fifth General Conference convene in Vienna on September 26, 1961.

Second International Conference on Operational Research

The conference on operational research, held at Aix-en-Provence from September 5 to 9, gave some indication of the growth of this branch of science since the war. It was the second of these conferences to be held, but the first under the auspices of I.F.O.R.S., the International Federation of Operational Research Societies.

I.F.O.R.S. was formed in January, 1959, and now has ten national Societies as members, from the United Kingdom, United States of America, France, Canada, Australia, India, Sweden, Norway, the Netherlands, and Belgium. These Societies represent from twenty members (Belgium) to 950 members (U.S.A.), a total of some 1700 scientists. In addition most of the societies have a substantial number of associate members. Other countries, including Japan, Germany and Spain, have formed operational research societies, and some or all of them may soon join the Federation.

Although the numbers attending the conference had to be limited, it was possible to invite people from many other countries as well as those mentioned. In fact, twenty-two countries, including Poland, Czechoslovakia and Hungary, were represented.

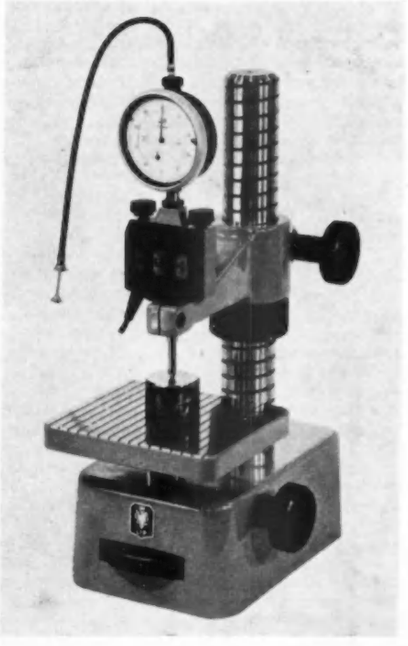
Operational research has not only grown geographically, but also in its range of applications, as can be seen from the following list of titles of the main sessions : Transport, the steel industry, control of production, the oil industry, local government, nuclear and electric power, computers, inventory control, national governments, military applications, mining, and human factors.

Altogether, eighty-four papers were presented and discussed, the first session dealing with Methodology. Another plenary session was devoted to the review of recent work on computers. One topic which dominated the Conference as a whole, was " simulation." " Simulation " consists in setting out the structure of a problem as an abstract model and then studying its behaviour under certain imposed conditions. This technique is complementary to that of mathematical analysis, which can become impossibly difficult because of the complexity of the situations to which it is applied. This same complexity makes electronic computers virtually a necessity for simulation models. Examples of simulation ranged from harbour installations to haulage in a coal mine, from a complete economic system to a man scheduling delivery vehicles. A subsidiary theme which ran as a connecting thread through many of the discussions was that of " heuristic decision processes." These concern the class of problems which cannot be resolved by the systematic application of a procedure, that is logical reasoning or numerical calculation. This resolution, therefore, depends only on judgment. It appears that by producing a computer routine which successfully imitates some aspects of these decisions, we may improve our under standing of the way they are made in the human brain.

Electric Comparator

Société Anonyme d'Horlogerie LIP, Besançon, in co-operation with the French National Physical Laboratories, has developed an electric comparator which it is stated combines high precision with small size, robustness and convenience in use. The instrument is distributed in the United Kingdom and Canada by Microtron, Ltd., 287, Finchley Road, London, N.W.3. The LIP comparator is 52mm wide and 21mm thick ; the overall length is approximately 120mm, or 158mm inclusive of dial gauge as shown in the accompanying illustration. It can be plugged directly, without a transformer, into 220V 50 c/s mains, and can also be supplied for other voltages and frequencies.

As the illustration shows, the instrument



Electric comparator for direct mains operation. Coloured light signals indicate " oversize," " undersize " and " correct." The instrument can be used in combination with a dial gauge, as here

indicates undersize (−), size within tolerance limits (=), and oversize (+). Sizes within limits are shown green, outside limits in red. The minimum tolerance range is stated to be ±0·0001in about the nominal dimension, and the sensitivity of the transition from " oversize," or " undersize," to " correct," or vice versa, is claimed to be as low as 0·00001in. Setting is carried out to slip gauges by means of the two knurled screws seen in the illustration.

Amplification is mechanical, and the gauge has a setting range of ±0·020in. The pressure exerted by the measuring point is approximately 4 oz. Power consumption is a few milliamperes, so that the contacts have a long life, and heating of the instrument is negligible. The body is of light alloy and the spindle, of 8mm diameter, is of stainless steel. The overall weight is quoted as 6 oz.

Hanover Machine Tool Exhibition

No. III—(*Concluded from page* 610, *October* 7)

MASCHINENFABRIK Spandau, Geh and Co. K.G., Berlin-Spandau, Am Oberhafen 16-20, exhibited automatic internal grinders and internal and face grinders with self-actuated loading and unloading of components. These machines have been developed from the maker's semi-automatic grinders which still require an operator to insert and take out the workpieces. Fig. 12 depicts the Model "SJPM 11" which was shown set up for grinding the bore and one face of a double pinion. The blanks are inserted in the magazine, the shape of the gate preventing insertion the wrong way round. A piston extracts one gear at a time and pushes it on the spigot arm of the loading device. On ejection of the previous workpiece, the loading arm lines up with the workhead centre and pushes the blank into the chuck against the rear face to ensure true running. The arm then retracts. The ground components accummulate in the outlet channel where a piston pushes them forward. The channel can be extended to another machine where the next operation is to be carried out.

A complete cold-forging installation capable of producing finished articles from bar stock was demonstrated by Cold Forging, Ltd. and A. Nothelfer & Söhne Werkzeug- und Maschinenfabrik, Ravensburg (Württ.), both members of the Camp Bird group of companies, 39, Dover Street, London, W.1. The seven machines shown on this occasion included the five basic units required by the system, viz. a bar-cropping machine, a pre-forming machine, a combined de-burring and chamfering machine, an automatic cycle surface treatment plant, and the actual cold-forging machine.

The model "S25" cropping and pre-forming machine is capable of cropping bars up to 1in diameter and 12-42 tons per square inch shear strength, to a minimum length of one quarter of the diameter, and a maximum length of 2in. Particularly in cases where more extensive preforming is required, it is better to use separate machine for cropping and preforming. The preforming unit shown is hydraulically-operated and designed to produce 1200 to 2400 parts per hour. It is stated that machines are available with a capacity of up to 3in.

For a reliable functioning of the process a thorough surface treatment must be carried out, involving degreasing, pickling, phosphating and lubrication. The plant (Fig. 13) is a revolving design, in which the articles are transferred from stage to stage in baskets holding 88 lb to 100 lb. The lubricating section is mechanically linked to the main plant but forms a separate unit in order to prevent contamination of the pickling and phosphating liquors with lubricants. The surface treatment plant has a central rise-and-fall turntable from which the treatment baskets are suspended. While the baskets are immersed they are oscillated in order to ensure that each article is evenly treated. The central pillar of the turntable is hydraulically raised for indexing to the next station. The lubricating unit utilises a screw conveyor to transport the articles through the lubricant. Throughput is stated to be 660 lb to 1320 lb per hour.

In order to prevent the cropping burr from being folded on to the component during cold forging, the blanks must be de-burred. At the same time the edges are chamfered so as to facilitate entry into the die. Any kind of blank irrespective of the shape of the contour, size, and depth, can be handled by adjusting the feed rollers and setting the central cutter head to the correct depth. The demonstration model was designed to take workpieces of from ¼in to 3in diameter and ¼in to 1¼in length, giving an output of 1800 to 5400 parts per hour.

The cold-forging machinery (Fig. 14) consists of heavy cast steel frame sections held together by tie bars. A motor of 20 to 75 h.p., depending on the model, drives the ram through a planetary reduction gearbox. It is claimed that this design is compact, and smooth and quiet in operation. The cam ejector system can be adapted to a wide range of different components. A pneumatic clutch and brake are fitted, and lubrication of the machine is automatic. The electric control system is mounted on "Silentblocs" to protect it from vibration and is situated in the front of the machine for easy access. Apart from providing automatic operation it incorporates protective devices as safeguards against overload or faulty running. The stroke, in the two models shown, was respectively 5in and 4in, and the maximum daylight between bed and ram 19in, and 17·75in. The bed areas were 28in by 31in and 23in by 23in, and the ram areas, 20in by 29in, and 23in by 27in. These machines can be operated at up to ninety strokes per minute.

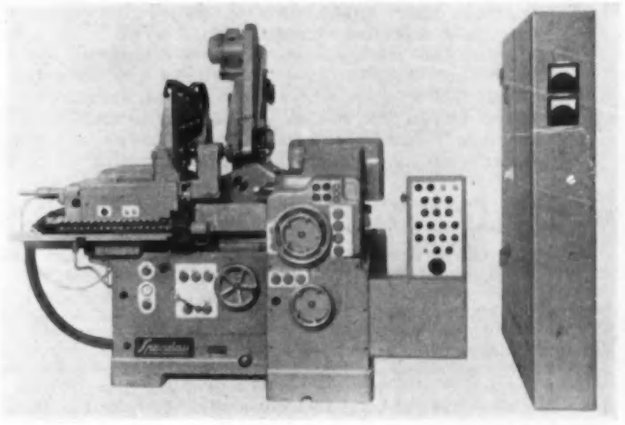


Fig. 12—Internal and facing grinder with fully automatic operation—Maschinenfabrik Spandau

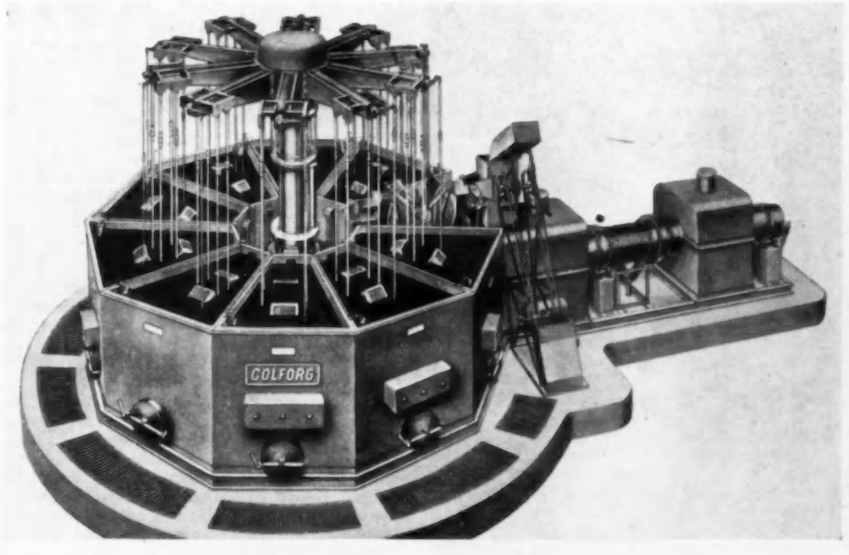


Fig. 13—Surface treatment plant for cold forging installat on—Cold Forging-Nothelfer

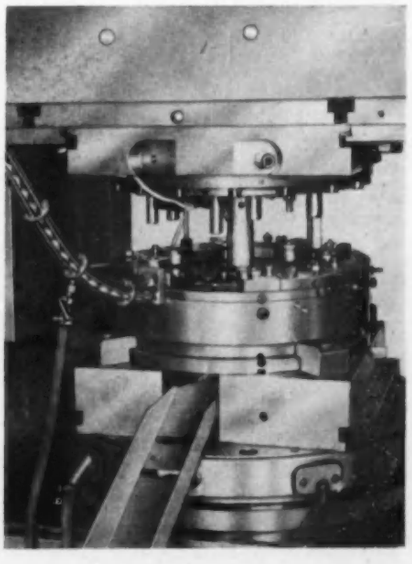


Fig. 14—Multi-stage cold forging die with automatic blank feed

THE AMERICAN SCENE

by Our American Editor

Open Coil Processes of Annealing and Gas Alloying

(No. II—*Concluded from page 612, October 7*)

Last year, the Lee Wilson Engineering Company, of Cleveland, Ohio, announced its newly developed "Open Coil Annealing Process" for sheet and tinplate. The unique feature of this system was the provision of separation or "air space" between the individual wraps of cold rolled steel coils. Annealing atmosphere gas was passed through these separations between the wraps of the coil so as to heat and cool the entire coil very rapidly and very uniformly. Continuing research into open coil annealing has now revealed that, in addition to conventional annealing, the process can be used to change the composition of the steel. It is now economically feasible to remove or add carbon, nitrogen and other alloying elements that can be gasified during the annealing of commercial-sized coils of cold rolled steel.

Open Coil Annealing

At the top of Fig. 8 is a graphic illustration of the type of coil annealed in standard annealing furnaces. This coil is so tightly wrapped that the heat for annealing can be absorbed by the surface area of the sides, top and bottom by radiation, convection and conduction as the gases travel over the coil for heating purposes. The very nature of this tightness excludes the possibility of atmosphere gases penetrating any more than slightly into the edges at the top and bottom of the coil. The bottom part of this

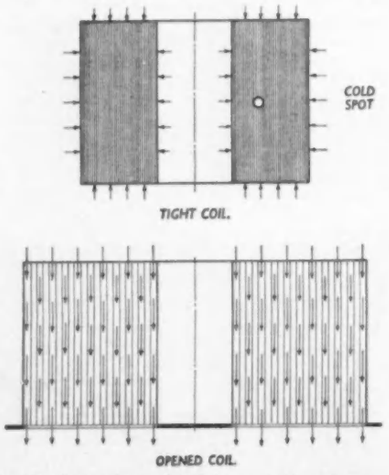


Fig. 8—Comparison of tightly wrapped and opened coils with regard to heat flow

diagram shows the open coil and the intimate contact which the heated gases have with all of the coil surface. This intimate contact of gases with the surface of the steel not only means that the gases cover all of the coil surface but the temperature difference between the steel and the atmosphere gases is within the readable tolerances of the average furnace thermocouple.

This close contact of the heated atmosphere gases is an outstanding feature of the open coil system, particularly from a gas alloying standpoint. It means that any gas equilibrium reaction which exists within the area of the steel is at the correct temperature level for the constituents of the atmosphere gas and the interstitials in the steel. The two interstitials of importance are carbon and nitrogen.

Gas Alloying

That certain gases will react at elevated temperatures with the impurity and alloying elements in steel has long been known, and considerable small-scale laboratory work has been done along this line. As long as twenty years ago, for example, M. Gensamer and J. R. Low were able to remove virtually all the carbon and nitrogen from small samples of sheet steel by annealing them in moist hydrogen. The commercial use of the known gas-metal reactions during annealing has been very limited because suitable large-scale equipment has not been available. In conventional batch annealing, the steel surfaces are not exposed to the annealing atmosphere so that the reactions cannot occur. With only a few exceptions, such as the silicon-bearing electrical steels, in continuous annealing the steel is not exposed to the annealing atmosphere long enough to permit the reactions to proceed beyond the very intial stages.

Neither of these limitations apply to open coil gas alloying and annealing. All the steel surface can be exposed to the annealing atmosphere for as short or as long a time as is necessary to ensure that the gas-metal reactions proceed to the desired end-point. Because of this, the potential uses of gas alloying by the open coil method are many, and a whole family of new steel products will undoubtedly result. Sufficient research has already been done to prove that a "direct-on" enamelling steel can be produced by open coil gas alloying. Several steel companies in the United States are already supplying commercial quantities of this "direct-on" steel to the enamelling trade. In the past, enamelled articles, such as kitchen stoves, refrigerators and washing machines, have been two-coat enamelled, the first coat being a blue ground coat and the second coat being a white or light-coloured cover coat. Objectionable enamel defects are formed whenever the cover coat is applied directly to conventional enamelling steels. With the open coil gas alloying process, however, it is possible to remove virtually all the carbon (to less than 0·005 per cent) from regular rimmed-steel sheet and thus make the steel suitable for the direct application of a defect-free white or light-coloured cover coat. The "direct-on" enamelling steel offers economic advantages to both the steel producer and the enameller. The steel producer need no longer supply low-metalloid steels, which are expensive to melt and roll, and the enameller can eliminate one of the two enamelling steps in his processing.

The very low carbon content of the "direct-on" enamelling steel is considerably below the carbon contents possible with commercial steel-making methods. However, it can be readily obtained by open coil annealing in the common annealing atmosphere gases that are generated from natural gas provided that controlled amounts of water are added to the gases during the soaking period of the annealing cycle. If hydrogen gas is used instead of the generated gases, and if the soaking time is from two to three times longer, the carbon content will be decreased even further and almost all of the nitrogen will be removed from the steel. The steel is then a non-ageing rimmed steel, and should be a less expensive substitute for the aluminium-killed steel presently used in many critical applications. The steel-works yield for aluminium-killed steel is inherently lower than that of rimmed steel, and the surface quality of the rolled aluminium-killed steel is characteristically poorer. Open coil gas alloying to produce this non-ageing rimmed steel will therefore provide both cost and quality advantages over aluminium-killed steel.

Other tests with open coil gas alloying have indicated that the process can also be used: (1) to improve the magnetic properties and ageing characteristics of the plain carbon and the silicon steels used in motors and other electrical equipment; (2) to restore carbon at the surface of high-carbon and alloy steel strip that has been surface-decarburised during previous processing; and (3) to make soft, easily rolled steels harder and stronger by increasing their carbon and/or nitrogen contents during annealing.

With regard to the latter, it has already been demonstrated on commercial-size coils that the harder tinplate tempers ("T-U," "T-5" and "T-6") can be produced by adding nitrogen to plain carbon open-hearth steel during open coil gas alloying. Until now, it has been necessary to add nitrogen to the molten steel processed for "T-U" and "T-5" tinplate and to add phosphorus to the molten steel processed for "T-6" tinplate. These additions have not only increased the cost of the ingots, but have also made it more difficult and expensive to roll the ingots to the thin gauges required for tinplate. It should now be possible to produce all the tinplate tempers from one economic, easily rolled steel and to establish the temper of the final product by controlling the temperature-time and atmosphere conditions during open coil gas alloying. On the other hand, many of the present grades of sheet steel must be melted to lower levels of carbon content than are consistent with optium surface quality, cleanliness and economic open-hearth practices. With the use of open coil gas alloying, it will be possible to melt to the optimum carbon content and then to lower carbon during annealing to the level desired in the final product.

Process Development

The initial conception of a process such as gas alloying is often as interesting as the process itself. The first indication of this phenomenon arose while setting up test cycles to prove the open coil annealing process. Four coils of steel of identical analysis were picked for the tests. Two coils were annealed in the open coil process. Two coils were annealed in standard bell type annealing equipment. The open coil annealed steel showed improved metallurgical results. The chemical analysis revealed a considerably lower carbon and nitrogen content, leading to the assumption that a different type of steel was used for each test. However on completely examining all the data, it was found that the improved metallurgical results were due to the reduction of carbon and nitrogen during annealing. Further test cycles substantiated the original data.

The above data brought to mind the problem of surface contamination of carbonaceous gas when annealing tinplate material. For this reason a test cycle for annealing tinplate was set up using bottled H_2N_2 gas of approximately 5 per cent H_2 with a −40 deg. dew point. A graph of this cycle is shown in Fig. 9. This cycle indicated a percentage build-up of approximately 1·2 CO, 0·3 CO_2 and a 1·5 maximum, 0·5 minimum H_2O during soaking. From many such tests, the indications were that controlled removal of carbon and nitrogen could be realised with proper control of atmospheres. A study of the action of the atmosphere gas components on steel at elevated temperatures showed that the following reactions take place.

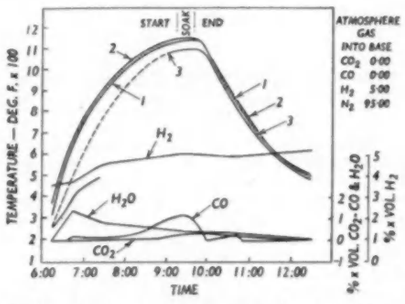


Fig. 9—Tinplate annealing cycle using a hydrogen-nitrogen gas with 5 per cent hydrogen

O_2 reacts with iron in steel to produce iron oxide (scaling)

$$2Fe+O_2=2FeO$$

and reacts with carbon in steel to lower its concentration (decarburising)

$$2Fe_3C+O_2=6Fe+2CO$$

N_2 is non-reactive in the generated atmosphere gases, reactive when dissociated from NH_3.

CO_2 reacts with iron to produce iron oxide.

$$Fe+CO_2=FeO+CO$$

and reacts with carbon to lower carbon content (decarburising)

$$Fe_3C+CO_2=3Fe+2CO$$

CO reacts slowly with iron to form iron carbide (carburising),

$$3Fe+2CO=Fe_3C+CO_2$$

and breaks down at low temperature to form CO_2 and free carbon (soot),

$$2CO=CO_2+C$$

H_2 reacts with iron oxide to reduce it to iron,

$$FeO+H_2=Fe+H_2O$$

and may be absorbed by high carbon steels ; non-decarburising if dehydrated.

H_2O reacts with iron to form iron oxide,

$$Fe+H_2O=FeO+H_2$$

and reacts with carbon in steel (decarburising),

$$Fe_3C+H_2O=3Fe+CO+H_2$$

Hydrocarbons are definitely carburising

$$3Fe+CH_4=Fe_3C+2H_2$$

Decarburising

In decarburising cycles, the steel is heated to approximately 1200 deg. Fah. in an atmosphere (*a*) inert or (*b*) reducing. The atmosphere gas is gradually changed to a highly decarburising gas or gases. At annealing temperature the grain structure starts a gradual movement to enlargement of the grains. Small elongated grains combine to make up single large grains. This build-up increases the pressure within the grain boundaries, forcing the interstitial constituents to attempt to escape. The carbon diffuses as C or Fe_3C. If the atmosphere at the surface of the steel is decarburising, the carbon will be carried away by any one of the following reactions :

$$C+H_2O=CO+H_2$$
$$Fe_3C+H_2O=3Fe+CO+H_2$$
$$C+CO_2=2CO$$
$$Fe_3C+CO_2=2CO+3Fe$$

As long as the temperature continues to enlarge grains and the surface atmosphere continues to carry away the diffused carbon, carbon will be removed from the steel. This internal pressure also forces the insoluble or free nitrogen to the surface of the steel together with the carbon. Any surface obstruction such as a change in gas equilibrium causing oxidation, carburising or equilibrium conditions between the carbon in the gas and the carbon in the steel, will slow down or stop the decarburising reaction.

Cycle of Reactions

Fig. 10 was plotted on a time-temperature graph, using hydrogen nitrogen gas as an atmosphere and follows the gas reactions

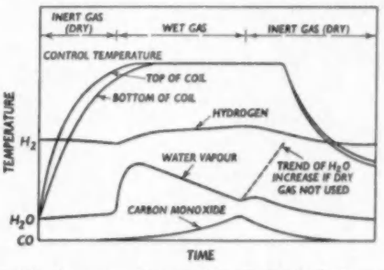


Fig. 10—Sequence of gas reactions during the hydrogen-nitrogen gas annealing cycle

through the alloying cycle. The cycle starts by purging the furnace with an inert dry atmosphere. As the steel is heated, the temperature curve gradually climbs to control temperature. The hydrogen content of the exhaust gas remains constant through this period. The H_2O content in the exhaust gas rises very gradually. At a point close to control temperature the moisture content of the entering gas is increased to the desired dew point. At this time a very marked increase in the exhaust dew point will be noted. Gradually CO is formed in the exhaust gases. A gradual increase in the H_2 content of the exhaust gas is also seen. At this point there is a constant flow of H_2 and no CO in the entering gas. Also at this time there is a marked reduction in exhaust dew point, even though there is a relatively high dew point in the entering gas.

The gradual rise of both H_2 and CO continues through the soak portion of the alloying cycle to a point where there is a sudden increase in exhaust dew point and a marked decrease in H_2 and CO. At this point the wet gas additions are stopped and a dry inert gas continues to flow through the furnace. This purge at temperature is continued until a satisfactory exhaust dew point is reached. The cooling cycle of the steel is then started. It is also noticed at this time that the H_2 content of the exhaust gas decreases to a point where it matches the incoming gas. The CO content of the exhaust gas decreases fairly rapidly to 0·0 per cent.

Cold Rolling Mill Expansion in New Jersey

AN important expansion programme to double capacity, improve quality and reduce the costs of producing high-carbon strip steels has been completed by the Athenia Steel Division, National-Standard Company, of Clifton, New Jersey. The expansion will make the firm more competitive with foreign and domestic producers serving American markets and it hopes to recapture some of the domestic market that has been lost to foreign producers. The works can now supply flat steels from 16in wide and 0·072in thick to ½in wide and 0·001in thick in coils to 5000 lb. It can also supply flattened round wire from ½in wide and 0·065in thick to 0·010in wide and 0·001in thick in coils to 1000 lb in a wide variety of finishes.

The more economic production of a wider range of close-tolerance strip steels will make Athenia Steel more competitive in many new markets, including flat spring steels for textile machines, corset stays, automotive valve and boot lid springs, women's shoe shanks, sewer rods, hand and power saw blades, power mower and outboard motor starter springs, and components for appliances, business machines, and computers. The expanded facilities were designed around three principles to make production more economic : (1) Equipment has been integrated to handle large, standard 500 lb and 1000 lb coils of both round and flat stock. This cuts the amount of handling for each ton produced and permits continuous processing of larger tonnages. (2) Processing speeds have been increased. (3) Processing has been set up in parallel lines rather than single lines to make more effective use of equipment and manpower.

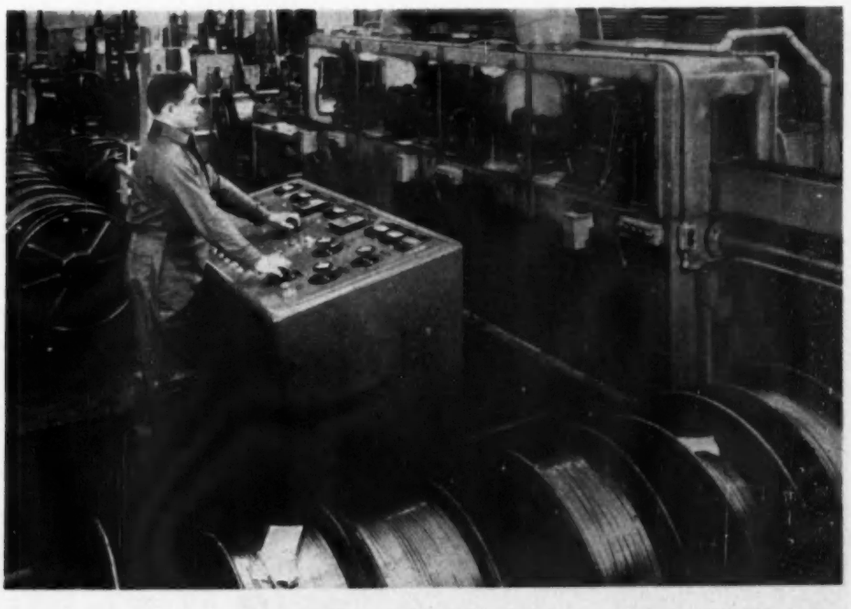


Fig. 1—Three-stand tandem wire flattening mill with 6½in by 2½in rolls operating at 3300ft per minute

THE AMERICAN SCENE *(Continued)*

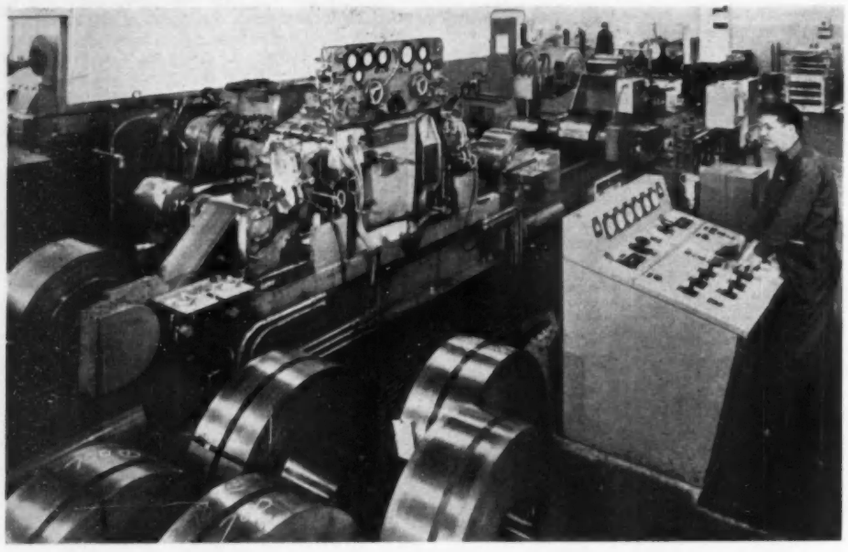
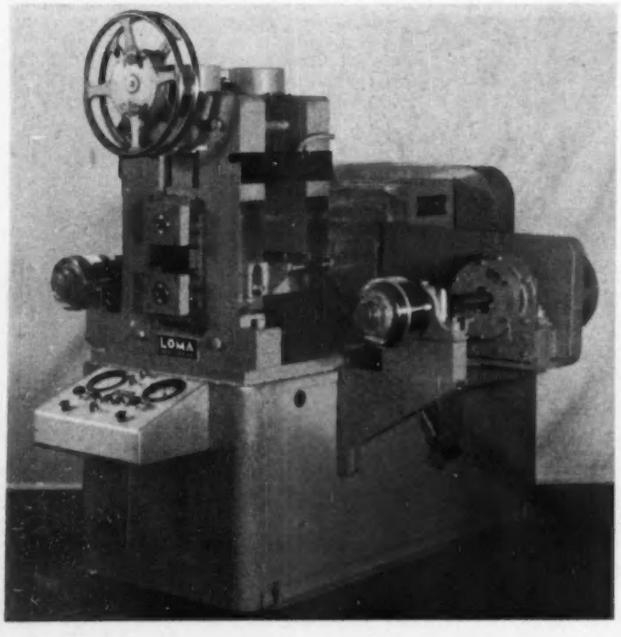


Fig. 2—13in wide Sendzimir reversing 20-high cold strip reduction mill operating at 1080ft per minute

The present expansion included expenditure of 2·2 million dollars for major production equipment and 800,000 dollars for buildings and utilities. Included in the new production equipment is a three-stand tandem wire flattening mill, a high precision strip steel cluster rolling mill, new slitting lines and new large-capacity annealing furnaces.

Fig. 1 shows the high-speed, three-stand tandem wire flattening mill for high-carbon steel wire installed at Athenia Steel. The new mill was built by the Waterbury Farrel Foundry and Machine Company and has a maximum speed of 3300ft per minute. The machine comprises a pay-off stand, three two-high mill stands with 6½in diameter by 2½in face width rolls, two non-driven edge rolling stands, " Flying Mike " continuous gauging equipment and a traversing recoiler. The new mill holds tolerances within 0·002in on width and within 0·00025in on thickness of the finished product. The high speed of the mill is combined with large reel capacities up to 1000 lb to permit longer production runs and more efficient material handling. Special cooling equipment has been included with the new mill to cool the steel and preserve its condition for further working.

Fig. 2 shows the new ZR-33-13 Sendzimir reversing cold strip mill designed to handle high-carbon strip up to 13in wide and 0·065in thick to final thicknesses down to 0·00125in. The new mill is of the 20-high design and employs work rolls of 1·125in diameter. The control system of the mill provides an extremely wide range of speeds. Slow speeds are available to preserve precision in rolling extremely thin materials. The high-carbon steel strip runs through the mill at up to 1080ft per minute during normal production. Winding tension is read directly in pounds as it runs through the mill. Tension is available in a low range to 5000 lb and in a high range to 15,000 lb. The electric motors and generators and motors for the mill are housed in a specially enclosed room. Air entering the room is filtered and kept under pressure to keep out dirt particles.



Cold reduction of strip on Loewe reversing combination rolling mill equipped with coiling reels

Low-Cost Reversing Narrow Strip Rolling Mill

High-precision rolling of thin-gauge ferrous and non-ferrous strip with accurate front and back tension control has been brought within reach of the smaller re-rolling mill, metals pilot plant and research laboratory by the development of a compact, low-cost two-high/four-high combination mill. Specialty strip processing shops can readily justify the installation of such a complete reversing cold reduction mill facility handling up to 6in wide strip at rolling speeds up to 250ft per minute, yet occupying 35 square feet of floor space and involving a capital investment of less than 20,000 dollars.

Designed and built by the Lowe Machine Manufacturing Company, of New York, the new 8in mill is furnished with two sizes of four-high work rolls, made of either alloy tool steel or solid tungsten carbide ; the 1½in size is used for normal cold reduction down to 0·002in thickness, and the ¾in size allows special ultra-thin finishing to gauges of less than 0·001in. In the four-high set-up, the machine handles up to ½in gauge ; the two-high arrangement is used for the hot or cold breakdown of heavier materials up to 1in thick, but is also available for skin pass rolling of thin strip. Work roll changes can be made by one operator within ten minutes, while a complete two-high/four-high changeover requires thirty minutes.

The production of close-tolerance stock is ensured by an exceptionally rugged mill design, employing steel housings of 160 square inches post area, super-precision needle roller journal bearings of 175,000 lb separating force capacity, a heavy-duty mill drive with double-helical gearing, and universal joint spindles, and twin handwheel worm drive screwdowns. The machine is powered by a 15 h.p. four-speed reversing drive offering constant horsepower from 40ft to 250ft per minute rolling speed.

The outstanding aspect of the new machine is its reversing strip coiling attachment allowing the two-way rolling of strip under accurate tension control. Mounted on brackets at either side of the mill, the two coiling shafts carry 8in diameter reels designed for a coil build-up of 6in. Both shafts are driven from the pinion stand and are provided with dual air-operated slip clutches and brakes of ultra-sensitive, low-inertia design. Selective operation through solenoid valves and pressure regulators precisely controls the front and back tensions desired for any given mill pass, as indicated by the gauges on the console. At the end of the pass the operator has only to actuate one selector switch to obtain mill drive reversal and electro-pneumatic changeover of the reels from pay-off to recoiler, and vice versa. The cumbersome handling and rethreading operations associated with the return of the coil from one to the other side of a conventional one-way mill are thus completely eliminated.

In recent tests the mill successfully reduced such tough metals as stainless steel, nickel, zirconium, platinum and beryllium copper, as well as such clad materials as rolled gold plate, thermostatic bimetal, indium-aluminium and silver-antimony. The resulting strip, even in ultra-thin gauges, showed excellent flatness, perfect surface finish and closest thickness tolerances.

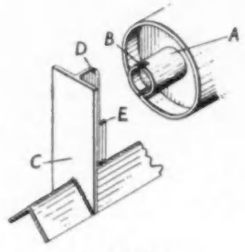
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

CONVEYORS

846,760 September 23, 1958.—CONVEYORS, Robert Sheldon Coleman, Mosley Engineering Works, Mosley Street, Burton-on-Trent.

This invention relates particularly to the rollers and the brackets on which endless belt conveyors are supported. The accompanying drawing shows one



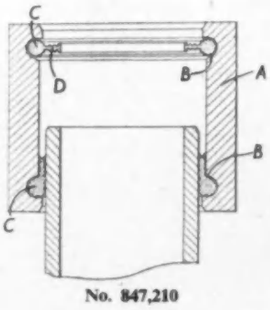
No 846,760

end of a conveyor roller and part of a bracket member designed to receive it. The roller consists of a cylindrical body with end plates having a central short stub axle. A ball bearing, slidably fitted on to each stub axle, is contained in a cylindrical housing which is slidably removable. The barrel *A* of each housing projects beyond an end plate, and forms a flange slotted radially as shown at *B*. A locating plate is fixed to the stub axle behind the bearing and the barrel is held in place by a circular spring wire which fits into a slight groove in its bore. The housing can be withdrawn by a strong pull, compressing the wire and leaving the bearing in place on the stub axle for inspection and replacement if necessary. Each stub axle and hence the roller as a whole is thus rotatably mounted on ball bearings carried by the non-rotating housings *A*. The bracket has upstanding arms *C* having webs *D* which fit into the slotted flanges of the bearing housings at each end of each roller. The housings rest on shoulders *E* as the rollers are slid on to the arms so that the rollers position themselves automatically perpendicular to the direction in which the belt is to move. It will be seen from the drawing that a bracket can be designed to carry a single horizontal roller and other drawings accompanying the specification show how brackets can be designed to carry two rollers in a shallow "V"-relationship or more than three rollers.—*August* 31, 1960.

PIPE COUPLINGS

847,210. November 13, 1958.—COUPLINGS FOR PIPES, Société Anonyme Eternit, Kapelle-op-den-Bos, Belgium.

The coupling for pipes described in this specification comprises a sleeve *A* with two grooves, each groove having a side wall *B* inclined to the axis of the sleeve so that the mouth of the groove is wider than the bottom. Rings made of resilient material are lodged in the grooves, each has a toroidal portion *C* and an



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inwardly directed annular web *D*, both being provided with annular extending ribs. When pipes are entered into the ends of the sleeve, each web *D* is bent inwards and is gripped between the sleeve and pipe. The pressure of a fluid passing through the coupling tends to compress the web and press it against the walls of the sleeve and pipe. At the same time, the toroidal portion *C* is pressed into the bottom of the groove. The entry of a pipe into the sleeve also causes the ribs to be deformed as shown and act as a number of sealing elements.—*September* 7, 1960.

INTERNAL COMBUSTION ENGINES

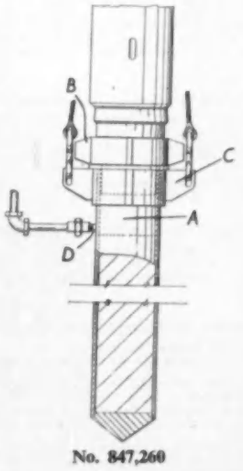
846,191 August 13, 1958.—HOLLOW CAST CRANKSHAFTS WITH LUBRICATION TUBES, Ford Motor Company, Ltd., 88, Regent Street, London, W.1.

In conventional hollow-cast crankshafts with capillary lubrication tubes for the main and connecting-rod bearings, the tubes are inserted into cross bores of the crankshaft or cast into it. These conventional constructions have the disadvantage that complicated devices are necessary to insert the tubes and perhaps expand or enlarge them. Cast-in lubrication tubes which seat firmly in the crankshaft without additional work have the disadvantage that a solid casting cannot always be avoided so that the tubes must be bored afterwards. It is an object of this invention to provide a hollow-cast crankshaft with lubrication tubes which is simple in construction and inexpensive. In the hollow cast crankshaft described and illustrated in the specification bores for insertion of the capillary lubrication tubes from the main bearings to the connecting-rod bearings and bridging the hollow spaces are preferably cast-in when the crankshaft is made. The tubes are somewhat shorter than the length of each bore so that they lie within the bearing surface. Before insertion into the bores the tubes are brushed or sprayed with a conventional self-hardening adhesive. The crankshaft is then either put into an oven at 200 deg. Cent. to harden the adhesive and cement the tubes firmly into its bores or allowed to stand, for the hardening of the adhesive. A self-hardening plastic adhesive, such as an epoxide type, may be used. The adhesive forms a tight and firm connection between crankshaft and lubrication tubes and it is proof against water, oil and heat and has a very high strength.—*August* 31, 1960.

PILING

847,260. June 16, 1958.—PRODUCTION OF CONCRETE PILES, Holmpress Piles, Ltd., Leads Road, Hull, Yorkshire (formerly of 80, Barnsley Street, Hull, Yorkshire). (*Inventor: Arthur Brannam Holmes.*)

A known method of pile production comprises the steps of forming a bore by driving a shoe at the lower end of a tube through the strata, filling the tube with concrete and then withdrawing it whilst adding more concrete to allow for the space previously occupied by the wall thickness of the tube. One or more subsequent redriving operations using a smaller diameter redrive tube also equipped with a detachable shoe are usually necessary to expand the pile to an adequate diameter for carrying the required load.



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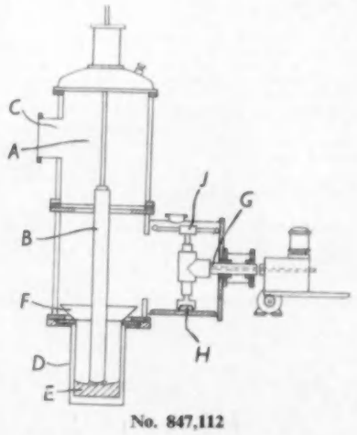
An object of the present invention is to provide a method of forming a pile in which any tendency to adhesion between the concrete and the drive tube or redrive tube, and which may lead to a void developing as the tube is withdrawn, is significantly, if not entirely, eliminated. Referring to the drawing, after the tube has been driven and filled to level *A* the helmet *B* is replaced and a gasket *C* introduced between the tube and the helmet to effect a seal. Compressed air is then introduced into the top of the tube above the level of concrete through the orifice *D* and is supplied during the progressive withdrawal of the tube. During the progressive withdrawal of the tube, the tup is allowed to rest on the helmet, this dead load serving to act as a safety valve to relieve any excessive pressure developed in the pile. By this method the use of air locks previously associated with the use of compressed air in pile formation is entirely avoided and a pile of good homogeneity and uniform density is achieved.—*September* 7, 1960.

FURNACES

847,112. April 24, 1957.—VACUUM ARC MELTING INSTALLATIONS, W. C. Heraeus G.m.b.H., (16) Hanau, Postfach 369, Germany.

In arc furnaces approximately 40 per cent of the operating time is used for melting and the other 60 per cent for charging and discharging, pumping and allowing the melted ingots to cool. The object of this invention is considerably to reduce these preparation and secondary times. It also enables an ingot of the first melt to be kept under vacuum when the crucible is replaced by another. Referring to the drawing, the vacuum arc furnace consists of an upper water-cooled part *A* into which a melting-off electrode *B* or its holding device is introduced, and which is evacuated through a sleeve *C*. This upper part of the furnace is separated from a central part which is also water-cooled and contains a sealing device. On a lower flange of the central part is a water-cooled crucible *D* into which the electrode is melted off to form an ingot *E*. During melting the upper edge of the crucible is covered by a protection ring *F*. The central part of the furnace is extended to one side and in this extension is a holding rod *G* which carries at its inner end a head with two hydraulically operated arms having a gripping device for a crucible lid *H* and a protection ring receiver



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J. The protection ring receiver carries devices which are adapted to hold the ring. The extension is separated by walls from the actual melting furnace to prevent the lid and the gripping devices in the position of rest from becoming dirty when the furnace is in operation. An upper lid (not shown), similar to the lid *H*, is provided for sealing off the upper part of the furnace. The holding rod can be moved in its longitudinal direction by a motor and rotated about its axis by a second motor. At the end of the first melt, the ingot, after a certain amount of cooling, is brought into contact with the unmelted portion of the electrode and welded to it. The ingot together with the electrode head is then drawn into the upper part of the furnace. To prevent any reaction between the ingot of the first melt and atmosphere, the upper part of the furnace is closed by an upper lid before the vacuum is released from the central chamber and before the changing of the crucible. The holding rod assembly is moved across into the central chamber and the protection ring raised and the lid *H* placed on the gasket of the crucible to be changed, and the vacuum is released from the chamber. The atmospheric pressure in the chamber presses the lid *H* and upper lid on to the gasket of the crucible and on to the sealing surface of the upper part of the furnace respectively. The crucible *D* is then released

and taken away from the furnace for cooling purposes. A new crucible, of larger diameter than the original crucible, is then installed. After this crucible and the central chamber have been evacuated, the lid is removed from the sealing surface of the upper part of the furnace and the ingot of the first melt is lowered into the empty crucible, so that then the second melt can be carried out.—*September* 7, 1960.

SHIPS

847,199. October 10, 1958.—OIL TANKERS, "Shell" Research, Ltd., St. Helen's Court, Great St. Helen's, London, E.C.3. (*Inventor : John Lamb.*)

The invention provides a method of recovering oil from sludge in an oil tanker and comprises passing the oil and/or sludge and water originating from tank washing operations into one or more separation compartments in the tanker. An oily layer allowed to separate from the water is stored in a compartment and then fed to a distilling plant on the tanker to separate the more volatile components and produce a fuel suitable for use in the ship's engines. The volatile components which separate in the distilling plant may be all vented to the atmosphere or part may be condensed. The condensate, which generally comprises a mixture of water and light hydrocarbons, is stored and later transferred to a shore installation. The methods thus provide a way of treating the sludge and all oil or sludge contaminated water from any part of the tanker, without pollution of coastal waters and at the same time give a fuel suitable for transfer to the tanker's bunkers. Treatment of the sludge and contaminated water in this way enables them to be disposed of continuously while at sea without pollution and a substantial economy in fuel to be effected.—*September* 7, 1960.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., Oct. 17.—BRISTOL AND WEST OF ENGLAND BRANCH : Royal York Hotel, Bath, "The Story of the Time Clock," J. Key, 8 p.m.

Tues., Oct. 18.—OXFORD AND DISTRICTS BRANCH : Employment Exchange, Oxford, "Industrial Electrical Safety," F. Galloway, 8 p.m. ★ WEST KENT BRANCH : Royal Star Hotel, Maidstone, Kent, Film : Ho v, 7 p.m.

Wed., Oct. 19.—NOTTINGHAM BRANCH : Nottingham Mechanics Institution, Trinity Square, Nottingham, "Modern Store Lighting," J. R. Just, 7.30 p.m. ★ WOLVERHAMPTON AND DISTRICT BRANCH : Chamber of Commerce District Bank Chambers, Lichfield Street, Wolverhampton, "Breakdown of Electrical Equipment—Some Remedial and Insurance Aspects," F. E. Noakes, 7.45 p.m.

Fri., Oct. 21.—LIVERPOOL AND DISTRICT BRANCH : Lecture Theatre, Chadwick Physics Laboratory, The University, Liverpool, Ramsey Regional Lecture, "Nuclear Power and Propulsion," R. V. Moore, 7.30 p.m. ★ STOKE AND CREWE BRANCH : Grand Hotel, Hanley, "Silicones and their Applications in the Electrical Industry," J. H. Davis, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Oct. 19.—SOUTH WALES SECTION : Welsh College of Advanced Technology, Cardiff, "The Use of Transistors in Pulse Circuitry," A. R. Owens, 6.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Tues., Oct. 18.—SOUTHERN REGION : Criterion Restaurant, Piccadilly, London, W.1, Discussion on "British Standard 1017. Part I : Sampling of Coal," opened by R. C. Tomlinson, 10.30 a.m.

Thurs., Oct. 20.—WESTERN REGION : Royal Hotel, College Green, Bristol, "Instrumentation of the Boilerhouse," R. W. Allan, 10 a.m.

ENGINEERS GUILD

Fri., Oct. 21.—KENT BRANCH : Bell Hotel, Bromley, Kent, Inaugural Meeting, 6.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Oct. 24.—BIRMINGHAM CENTRE : Visit to Worcestershire Police Headquarters and Museum, C.I.D., Hindlip Hall, Worcester, 7.30 p.m.

INSTITUTE OF FUEL

Wed., Oct. 19.—Institution of Civil Engineers, Great George Street, London, S.W.1, Discussion on "Pulverised Fuel Flames," led by G. G. Thurlow, 5.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Oct. 18.—SOUTHERN BRANCH : Technical College, Southampton, Joint meeting with the Royal Institution of Naval Architects, "Interaction Between Ships Close Aboard in Deep Water," R. N. Newton, 7.30 p.m.

INSTITUTE OF METALS

Mon., Oct. 17.—LONDON LOCAL SECTION : Northampton Polytechnic, St. John Street, London, E.C.1, Joint meeting with the Institute of Metal Finishing. "Electroplating Processes and Effect on Fatigue Strength and Embrittlement of the Substrate," C. Williams, 6.15 p.m.

Tues., Oct. 18.—North East Metallurgical Society, Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Techniques in Investigation of Metallurgical Failures in Aircraft Components, D. A. Ryder, 7.30 p.m.

Thurs., Oct. 20.—SHEFFIELD LOCAL SECTION : Applied Science Building, The University, St. George's Square, Sheffield, Symposium on "Solidification," 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Oct. 25.—N.W. BRANCH : Chemical Engineering Lecture Theatre, Manchester College of Science and Technology, Jackson Street, Manchester, "Computors and their Application in Chemical Engineering," D. W. Holman and J. J. Settle, 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Oct. 18.—Great George Street, Westminster, London, S.W.1, "Zambesi Hydro-electric Development at Kariba : First Stage," Sir Duncan Anderson, T. A. L. Paton, and C. L. Blackburn, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Oct. 17.—MERSEY AND N. WALES CENTRE : Town Hall, Chester, "Short-Circuit Ratings for Mains Cables," G. S. Buckingham, and "A Basis for Short-Circuit Ratings for Paper-Insulated Cables up to 11kV," L. Gosland and R. G. Parr, 6.30 p.m. ★ N.E. MEASUREMENT AND ELECTRONICS GROUP : Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne, Chairman's Address, E. D. Taylor, 6.15 p.m. ★ SCOTTISH ELECTRONICS AND MEASUREMENTS GROUP : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Chairman's Address, J. Stewart, 6 p.m. ★ N. STAFFORDSHIRE SUB-CENTRE : County Technical College, Stafford, "The Shielding of Overhead Lines Against Lightning," J. H. Gridley, 6.30 p.m. ★ WESTERN SUPPLY GROUP : Electricity House, Colston Avenue, Bristol, 1, Chairman's Address, 6 p.m.

Tues., Oct. 18.—NORTH MIDLAND UTILISATION GROUP : Leeds and County Conservative Club, South Parade, Leeds, 1, "The Design of Electromagnetic Pumps for Liquid Metals," D. A. Watt, 6.30 p.m. ★ NORTH-WESTERN MEASUREMENT AND CONTROL GROUP : Engineers' Club, Albert Square, Manchester, "Development of the Formulae of Electromagnetism in the M.K.S. System," P. Vigoreux, 6.15 p.m. ★ SOUTH-EAST SCOTLAND SUB-CENTRE : Carlton Hotel, North Bridge, Edinburgh, Chairman's Address, I. S. Fraser, 7 p.m.

Wed., Oct. 19.—SUPPLY SECTION : Savoy Place, London, W.C.2, Chairman's Address, "The Developing Engineer," J. E. L. Robinson, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION : All day visit to the General Electric Company, Ltd., Erith Engineering Works, Erith, Kent, 10 a.m. ★ SHEFFIELD SUB-CENTRE : Grand Hotel, Sheffield, Chairman's Address, "Electrical Contracting in Commerce and Industry," E. J. Lilleker, 6.30 p.m. ★ NORTH LANCASHIRE SUB-CENTRE : N.W.E.B. Demonstration Theatre, Duke Street, Barrow, "Some Considerations in the Application of Power Rectifiers and Convertors," J. P. McBreen, 7.15 p.m. ★ SOUTH-WEST SCOTLAND SUB-CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Inauguration of Sub-Centre Chairman, W. L. Kidd ; "A Basis for Short-Circuit Ratings for Paper-Insulated Cables up to 11kV," L. Gosland and R. G. Parr, 6 p.m. ★ SOUTHERN CENTRE : Technical College, Brighton, "A Survey of Street Lighting and its Future," W. R. Stevens and H. M. Ferguson, 6.30 p.m. ★ SOUTH-WESTERN SUB-CENTRE : Plymouth "B" Generating Station, Prince Rock, Plymouth, Chairman's Address, F. C. Isaac, 3 p.m.

Thurs., Oct. 20.—CAMBRIDGE ELECTRONICS AND MEASUREMENT GROUP : Cavendish Laboratory, Cambridge, "Frequency Variations of Quartz Oscillators and the Earth's Rotation in Terms of the N.P.L. Caesium Standard," L. Essen, J. U. L. Parry and J. McA. Steele, 8 p.m. ★ NORTH MIDLAND CENTRE : Lecture Theatre, Y.E.B. Offices, Ferensway, Hull, "The Supply Authorities' Problems," H. Anderson ; "The Consultant's Problems," C. H. Nicholson, and "The User's Problems," A. Minty, 6.30 p.m. ★ IRISH BRANCH : Physical Laboratory, Trinity College, Dublin, Chairman's Address, C. V. O'Donnell, 6 p.m.

Fri., Oct. 21.—SOUTHERN CENTRE : S.E.B. Showrooms, Newport, Isle of Wight, "The Application of Irradiation in Industry," M. C. Crowley-Milling, 6.30 p.m.

Mon., Oct. 24.—LONDON GRADUATE AND STUDENT SECTION : Savoy Place, London, W.C.2, Chairman's Address, "Southern Region, Kent Coast Electrification Scheme—Power Supply Apparatus," A. Porter, 6.30 p.m. ★ EAST ANGLIAN SUB-CENTRE : Electric House, Ipswich, "Electrical Installation Practice," E. J. Sutton, 6.30 p.m. ★ NORTH-EASTERN CENTRE : Neville Hall, Westgate Road, Newcastle upon Tyne, "Safety in the Utilisation of Electricity," S. J. Emerson, 6.15 p.m. ★ SHEFFIELD SUB-CENTRE : Angel Hotel, Brigg, "Electrical Contracting in Commerce and Industry," E. J. Lilleker, 7 p.m. ★ NORTH-WESTERN CENTRE, EDUCATION DISCUSSION CIRCLE : Technical College, Bolton, Discussion on "Selection of Students for Appropriate Courses," opened by G. W. Carter, and A. J. Jenkinson, 6.15 p.m. ★ SOUTH MIDLAND ELECTRONICS AND MEASUREMENT GROUP : James Watt Memorial Institute, Birmingham, "Automatic Control of Machines for Assembling Bicycle Parts," A. V. Hemingway and R. L. Dressler, 6 p.m. ★ WESTERN UTILISATION GROUP : S. Wales Institute of Engineers, Park Place, Cardiff, Chairman's Address, "Developments in Electrical Plant for Industry," J. M. Ferguson, 6 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., Oct. 17.—NORTH-EAST BRANCH : Crown Hotel, Clayton Street West, Newcastle upon Tyne, 1, Annual General Meeting, 7.30 p.m. ★ NORTH STAFFORDSHIRE BRANCH : North Staffordshire Technical College, Stoke-on-Trent, "Investment Casting," D. H. Farrimond, 7.15 p.m.

Wed., Oct. 19.—YORKSHIRE BRANCH : Midland Hotel, Bradford, "Admiralty Salvage," W. Douglas Miller, 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Tues., Oct. 18.—Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, "The Operating Experience of the Diesel Electric Train Sets on the Hastings Service," W. J. A. Sykes, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Oct. 14.—E. MIDLANDS GRADUATES' SECTION : Visit to Clayton Dewandre Company, Ltd., Titanic Works, Lincoln, 7 p.m.

To-day to Sun., Oct. 14 *to* 16.—N.W. GRADUATES' SECTION : Palace Hotel, Buxton, Autumn Conference, Theme : Widening the Engineer's Outlook and Helping Him to Appreciate How the Various Members of the Industrial Team Should Work Together.

Mon., Oct. 17.—DERBY A.D. CENTRE : Midland Hotel, Derby, "An Introduction to the Free-piston Engine," R. M. Hosie, and K. A. Troth, and Annual Meeting, 7.30 p.m. ★ SCOTTISH A.D. CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "The Successors to the Steam Locomotive," L. F. R. Fell, and K. Tyler, 7.30 p.m. ★ MIDLAND GRADUATES' SECTION : Visit to Science Museum, Newhall Street, Birmingham, 7 p.m.

Tues., Oct. 18.—RUGBY SUB-BRANCH : College of Engineering Technology, Rugby, Repetition of Graham Clark Lecture, "The Engineer and Civilisation," Sir Hugh Beaver, 6.30 p.m. ★ SOUTH WALES BRANCH : King's Head Hotel, Newport, Monmouthshire, "Corrosion in Engineering," J. Hinde, 6 p.m.

Wed., Oct. 19.—EAST MIDLANDS BRANCH : Room 104, College of Technology and Commerce, Leicester, Chairman's Address, "Aspects of Manufacturing Research and Development in Russia," D. F. Galloway, 7.15 p.m. ★ NORTH EASTERN A.D. CENTRE : Chemistry Lecture Theatre, Leeds, "Recent Developments in Combustion," J. S. Clarke, 7.30 p.m. ★ SOUTHERN GRADUATES' SECTION : A.W.R.E., Aldermaston "Engineering Vibration," W. H. Johnson and E. J. Dent, 3 p.m. ; ★ WESTERN GRADUATES' SECTION : Plymouth and Devonport Technical College, Plymouth, "The Bristol Siddeley 3MW Generator," P. McMahon, 7.30 p.m.

Thurs., Oct. 20.—N.E. BRANCH : Stephenson Building, Claremont Road, Newcastle upon Tyne, Discussion on "Wetness in Steam Cycles," B. Wood, 6.15 p.m. ★ EAST MIDLANDS GRADUATES' SECTION : College of Further Education, Grantham, "The Fatigue of Railway Rolling Stock Axles—Yesterday and To-day," M. Sedgwick, 7.15 p.m. ★ YORKSHIRE GRADUATES' SECTION : Hotel Metropole, Leeds, "Vibration Testing Techniques," R. J. Coleman, 6.30 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., Oct. 20.—Geological Society, Burlington House, Piccadilly, London, W.1, Discussion of the papers "Mining of Cupreous Stockwork Ores at Rio Tinto, Spain," R. N. Pryor, and "Extraction of Copper and Silver by the Segregation Process in Peru," F. Pollandt, 5 p.m.

INSTITUTION OF PLANT ENGINEERS

Wed., Oct. 19.—KENT BRANCH : King's Head Hotel, High Street, Rochester, "Refractory Brickwork for Boilers and Furnaces," N. W. Hinchcliffe, 7 p.m. ★ LONDON BRANCH : Visit to the Research Laboratories of the General Electric Company, Ltd., Wembley, Middlesex, 10.15 a.m.

Thurs., Oct. 20.—BLACKBURN BRANCH : Castle Hotel, Blackburn, "Comfort Heating," W. N. Shires, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Oct. 17.—SHEFFIELD GRADUATE SECTION : Robert Jenkins and Co., Ltd., Wortley Road, Rotherham, "Production Welding Techniques," 6.30 p.m. ★ NORTHERN REGION : Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne, "The Institution and the Commonwealth," W. F. S. Woodford, 7 p.m.

Wed. Oct. 19.—MIDLANDS REGION : James Watt Memorial Institute, Great Charles Street, Birmingham, "Precision Investment Casting Techniques," W. N. Jones, 7 p.m.

Thurs., Oct 20.—SCOTLAND REGION : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Process Planning and Machine Tool Contol Systems," A. Tack and J. Brett, 7.30 p.m. ★ SOUTH EASTERN REGION : Royal Commonwealth Society, London, "The Manufacture of Marine Propellers with particular reference to the Foundry," J. M. Langham, 7 p.m. ★ SOUTHERN REGION : Polygon Hotel, Southampton, "Equipment Peripheral to Digital Computers" E. J. Petherick 7.15 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Mon., Oct. 17.—NORTHERN COUNTIES BRANCH : Cleveland Scientific and Technical Institution, Newcastle upon Tyne, Installation of the Branch Chairman, and Chairman's Address, E. Ibbotson, 6.30 p.m.

Tues., Oct. 18.—LANCASHIRE AND CHESHIRE BRANCH : College of Science and Technology, Manchester, Chairman's Address, W. Merchant, 7 p.m.

Wed., Oct. 19.—YORKSHIRE BRANCH : Griffin Hotel, Leeds, Chairman's Address, W. Eastwood, 6.30 p.m.

Thurs., Oct. 20.—YORKSHIRE BRANCH : Royal Victoria Hotel, Sheffield, Repeat of Chairman's Address, W. Eastwood, 6.30 p.m.

INSTITUTION OF WATER ENGINEERS

Fri., Oct. 21.—Lecture Hall, Leeds City Art Gallery, The Headrow, Leeds, 1, One-day conference on "Surface Water Resources and the Drought of 1959," 10 a.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 14.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Nuclear Fuels," Robin F. W. Guard, 7 p.m.

Fri., Oct. 21.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Boiler Management in Small Plants," L. Clegg, 7 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Mon., Oct. 17.—Literary and Philosophical Society, Newcastle upon Tyne, Presidential Address, J. B. Woodeson, 6.15 p.m.

PLASTICS INSTITUTE

Mon., Oct. 17.—City of London College, Moorgate, London, E.C.2, "The Structure of the Plastics Industry," C. J. G. Stanley, 6.15 p.m.

REINFORCED CONCRETE ASSOCIATION

Wed., Oct. 19.—11, Upper Belgrave Street, London, S.W.1, "Lift Slab Design and Construction," F. R. Benson, 6 p.m.

ROYAL INSTITUTE OF CHARTERED SURVEYORS

Wed., Oct. 19.—12, Great George Street, Westminster, London, S.W.1, "Future Practice and Procedure in Quantity Surveying," K. K. Dale, 6 p.m.

ROYAL METEOROLOGICAL SOCIETY

Wed., Oct. 19.—49, Cromwell Road, London, S.W.7, "Spectroscopic Observations of the Water-Vapour Content of the Stratosphere," J. T. Houghton and J. S. Seeley, 5 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., Oct. 19.—CORROSION GROUP : 14, Belgrave Square, London, S.W.1, "Anodic Protection, (*a*) Principles ; (*b*) Practical Application," C. Edeleanu and J. B. Cotton, 6 p.m.

Thurs., Oct. 20.—ROAD AND BUILDING MATERIALS GROUP : 14 Belgrave Square, London, S.W.1, "The Manufacture and Properties of Wood Chipboards," L. E. Akers, 6 p.m.

Mon., Oct. 24.—CORROSION GROUP : 14, Belgrave Street, London, S.W1, Cathodic Protection Panel Meeting, Brains Trust, J. S. Gerrard, J. H. Morgan, K. A. Spencer and W. G. Waite, 6 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

To-day, Oct. 14.—MIDLAND SECTION : Gosta Green College of Technology, Aston Street, Birmingham, "Fundamentals of Temperature Measurement," E. B. Jones, 6.30 p.m.

Wed., Oct. 19.—BRISTOL SECTION : Dept of Physics, The University, Royal Fort, Bristol, 8, "Characteristics of Differential Producers for Flow Measurement," H. E. Dall, 7.30 p.m.

Thurs., Oct. 20.—EAST MIDLAND SECTION : University, Leicester, "Instrumentation at the British Railways Research Dept., Derby," J. H. Littlewood and A. Kettlety, 7.15 p.m. ★ GRANGEMOUTH SECTION : Leapark Hotel, Grangemouth, "Analytical Instruments for Process Control," D. G. Stevenson, 7 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Fri., Oct. 21.—39, Elmbank Crescent, Glasgow, "The Physical Metallurgy of Steel," R. W. K. Honeycombe, 6.45 p.m.

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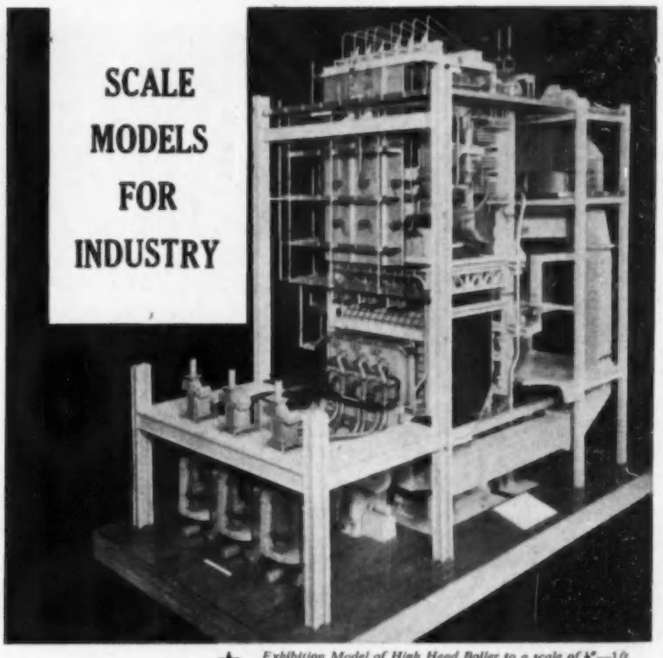

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This complicated detail perfect scale model of a high head boiler made in our Northampton works, is just one example of the extreme accuracy and specialized knowledge required to achieve a perfect miniature of the real thing. Leading Industrialists, Engineers and Architects of international repute, confidently entrust this kind of work to us.

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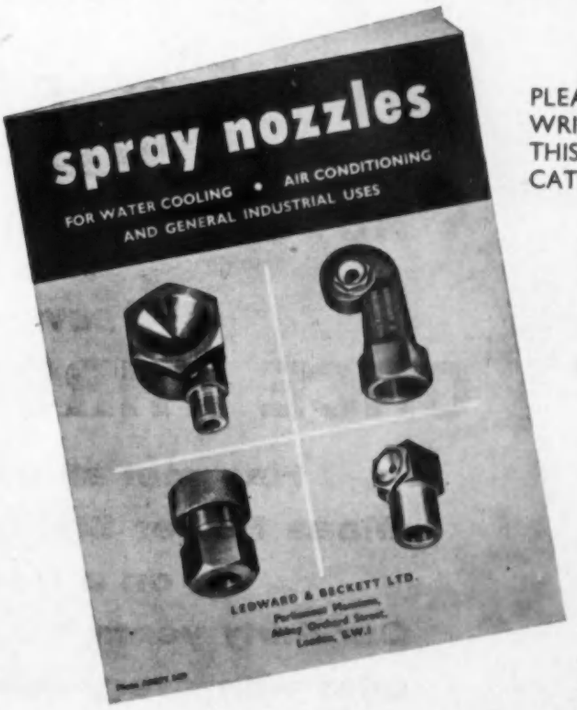

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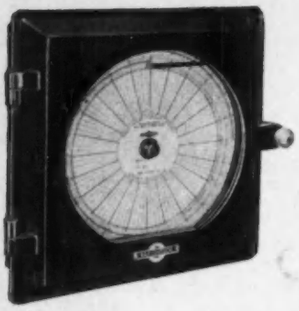

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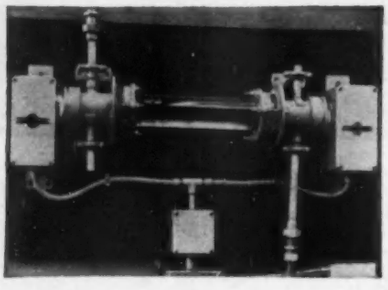

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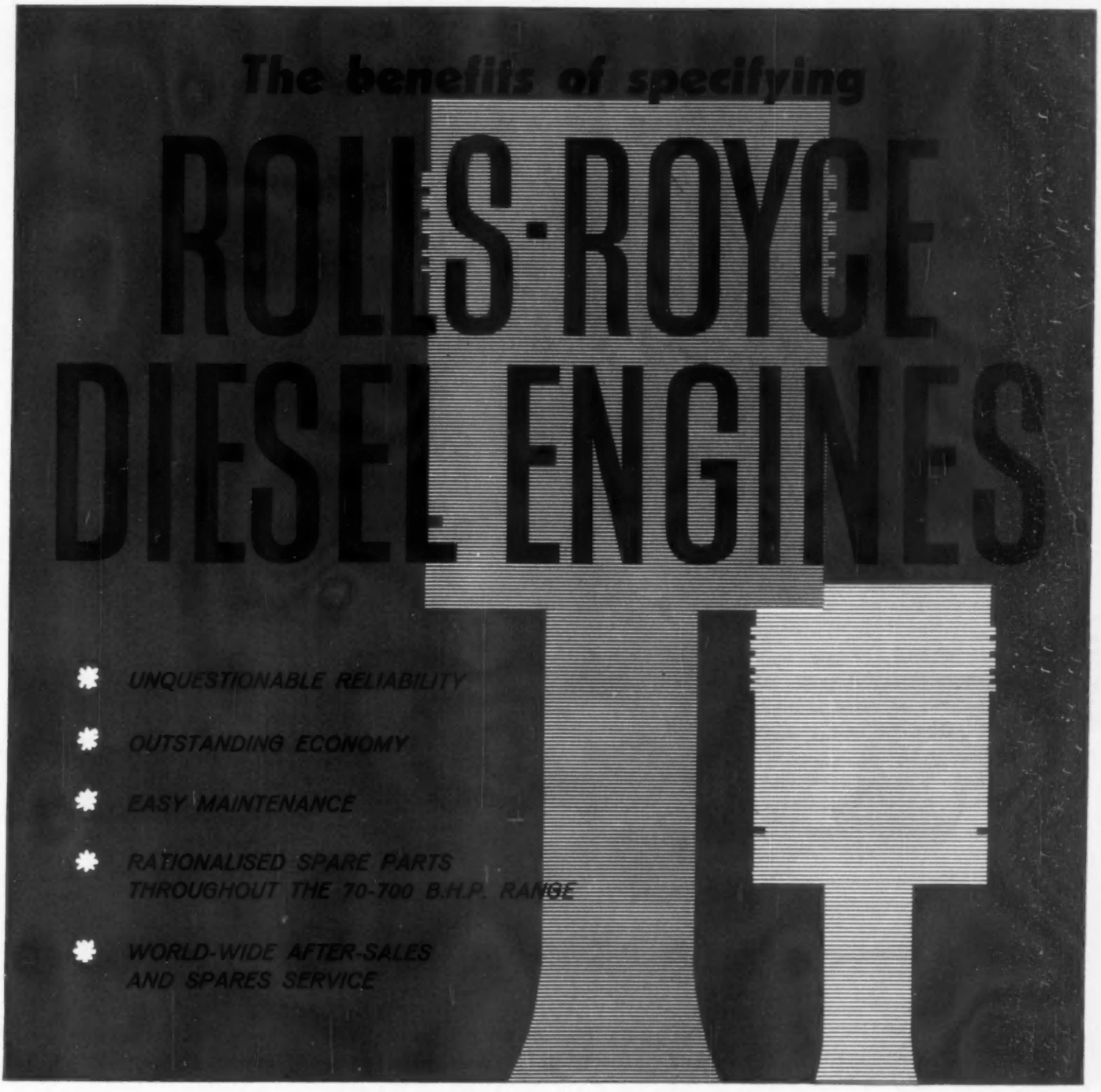

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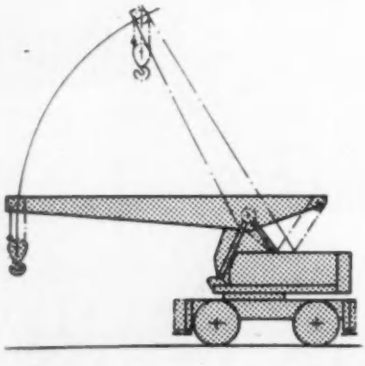

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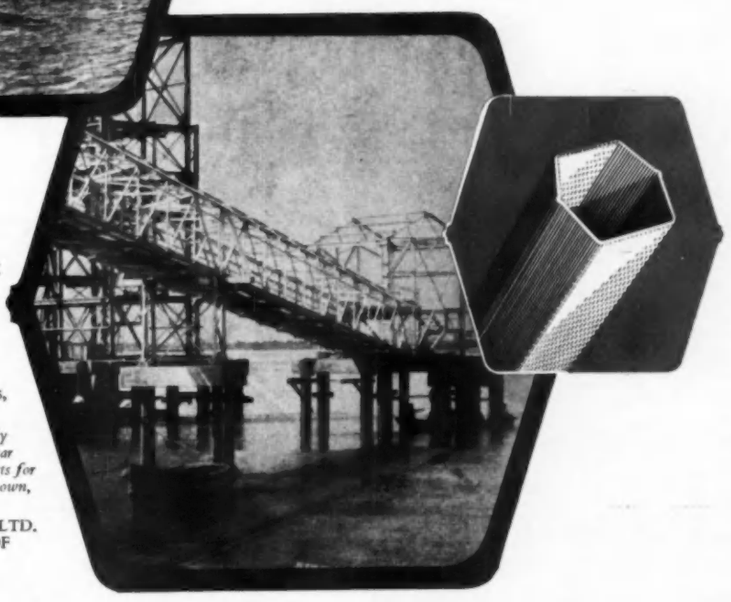

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Illustrations show "Rendhex" Columns forming (above) a "strongpoint" in a recently constructed jetty to berth 10,000 ton bulk sugar freighters and (below) acting as piling supports for a bulk sugar off-loading conveyor at Georgetown, British Guiana, for

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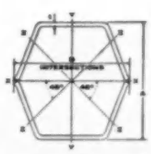

TABLE OF PROPERTIES

"Rendhex" Column No.	Size (Ins.)			Weight of Rolled Section lbs. per Lin. ft.	Weight of complete Col. (incl. Weld) lbs. per Lin. ft.	Area of complete Col. (excl. weld) Sq. ins.	Moment of Inertia (Ins.⁴)			Radii of Gyration (Ins.)			Section Moduli (Ins.³)		
	A	B	t				About XX	About YY	About ZZ	About XX	About YY	About ZZ	About XX	About YY	About ZZ
No. 3	13	12½	½	36·15	72.50	21·26	469·3	381·3	425·3	4·69	4·23	4·47	72.20	58·70	57·30
No. 4	16	16½	½	58·30	117·75	34·30	1214	1038	1126	5·95	5·50	5·73	151·75	125·82	116·15
No. 6	20	20	0·7	80·70	162·80	47·47	2657·7	2203·5	2430·6	7·49	6·81	7·16	265·80	218·60	207·20

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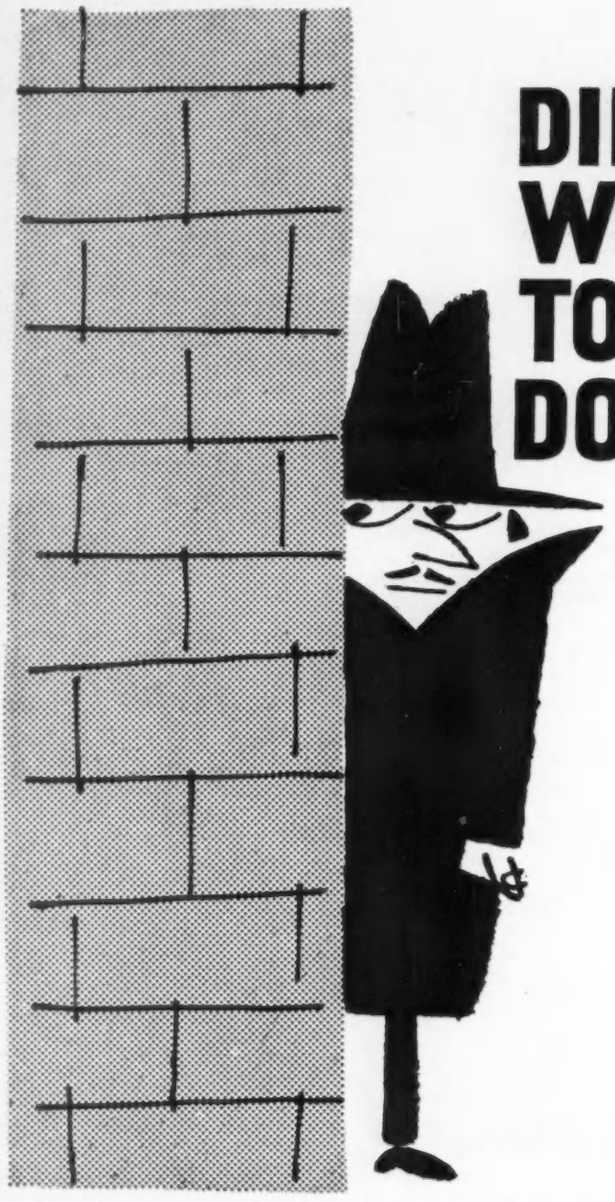

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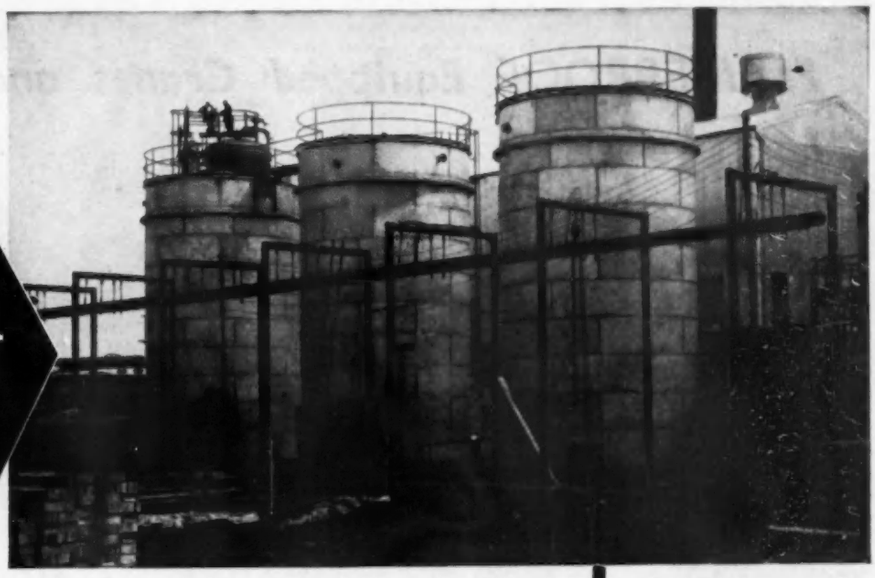
Rileys of Batley



3—Stainless Steel Shift Tanks, 17′ 6″ diameter x 30′ 0″ high for Nitric Acid, installed at Stanford-le-Hope. Design and site construction by Rileys of Batley. 100% x-ray of circumferential welded seams, spot x-ray of vertical seams to Insurance Survey requirements. This Contract was completed recently, and the illustration is reproduced by courtesy of Fisons Limited, Harvest House, Felixstowe, Suffolk.

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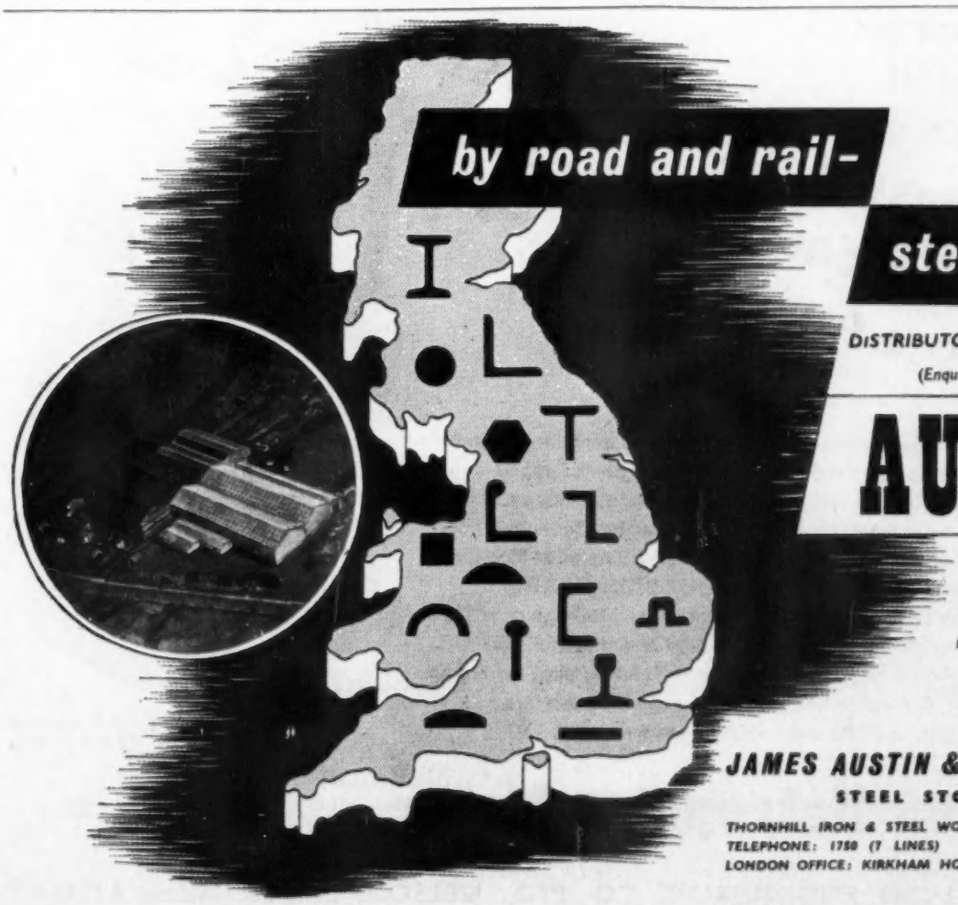

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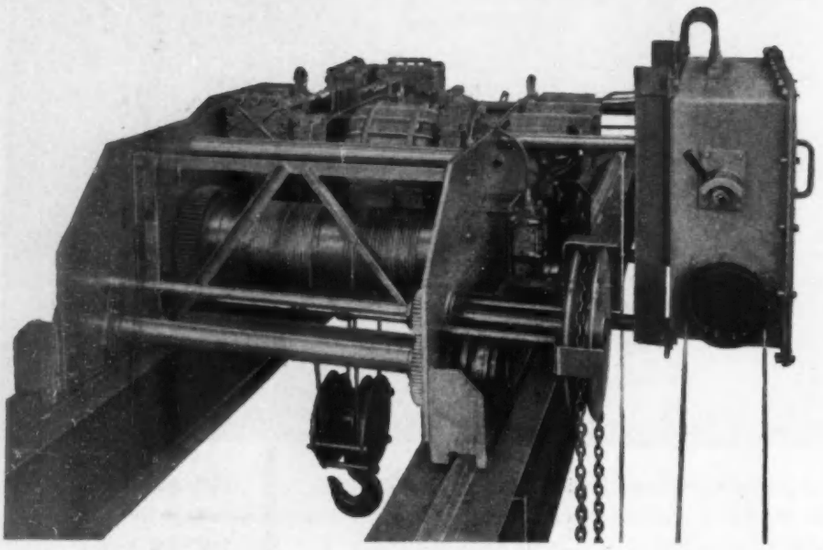

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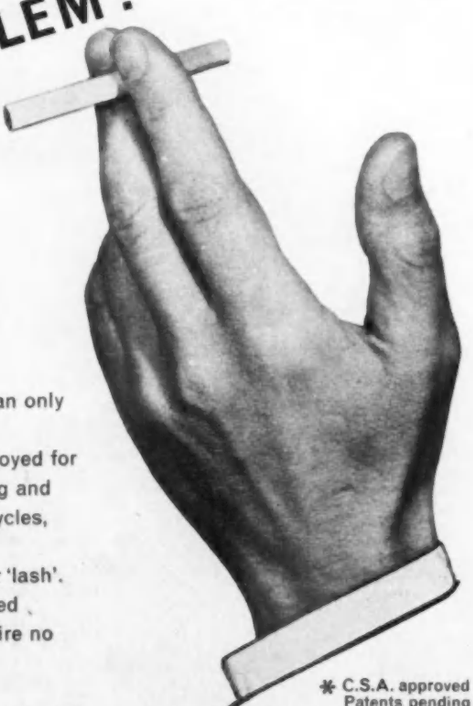

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Nelson Hetropolar Motor*

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DU & DQ

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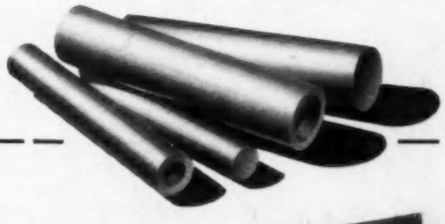
Glacier D.U. dry bearings are composed of thin steel strip with a porous bronze coating impregnated with a mixture of a fluoro-carbon plastic (P.T.F.E.) and lead.

DQ



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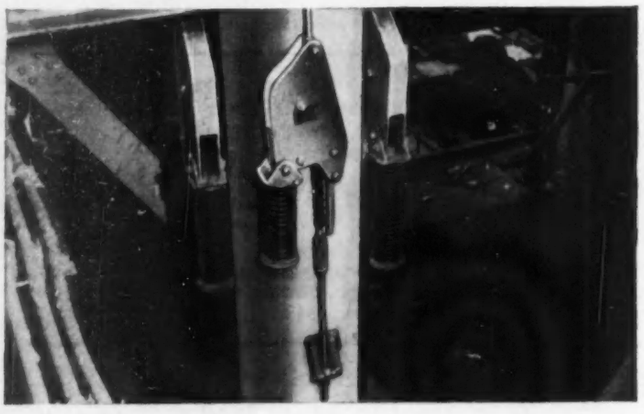

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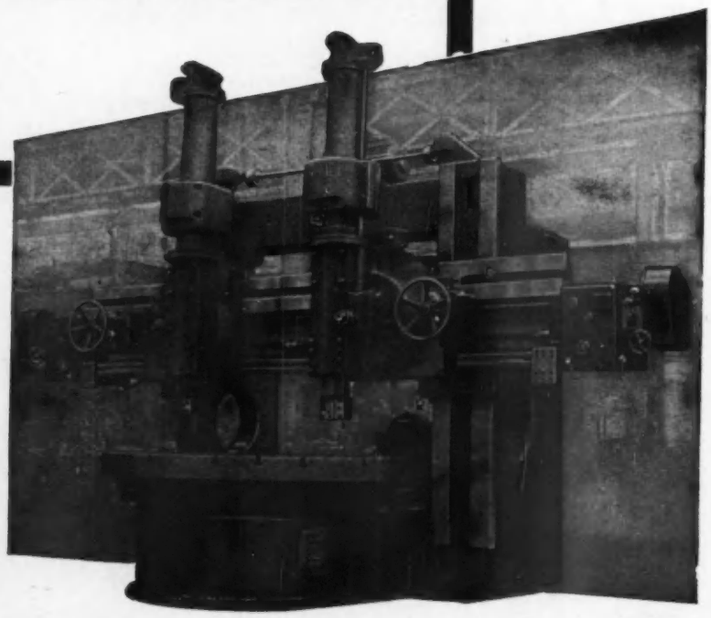

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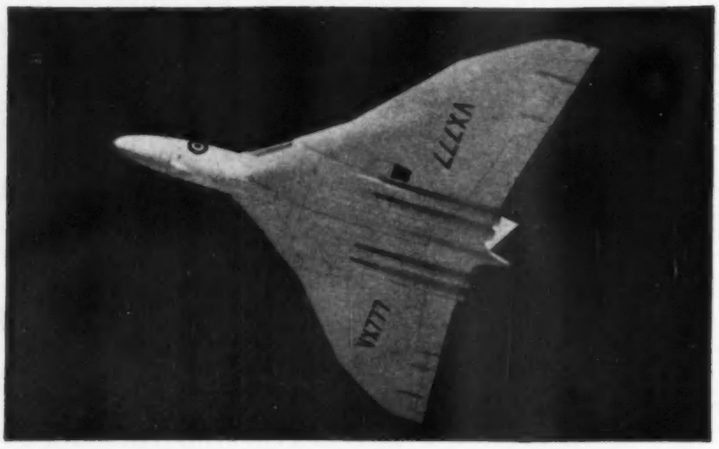
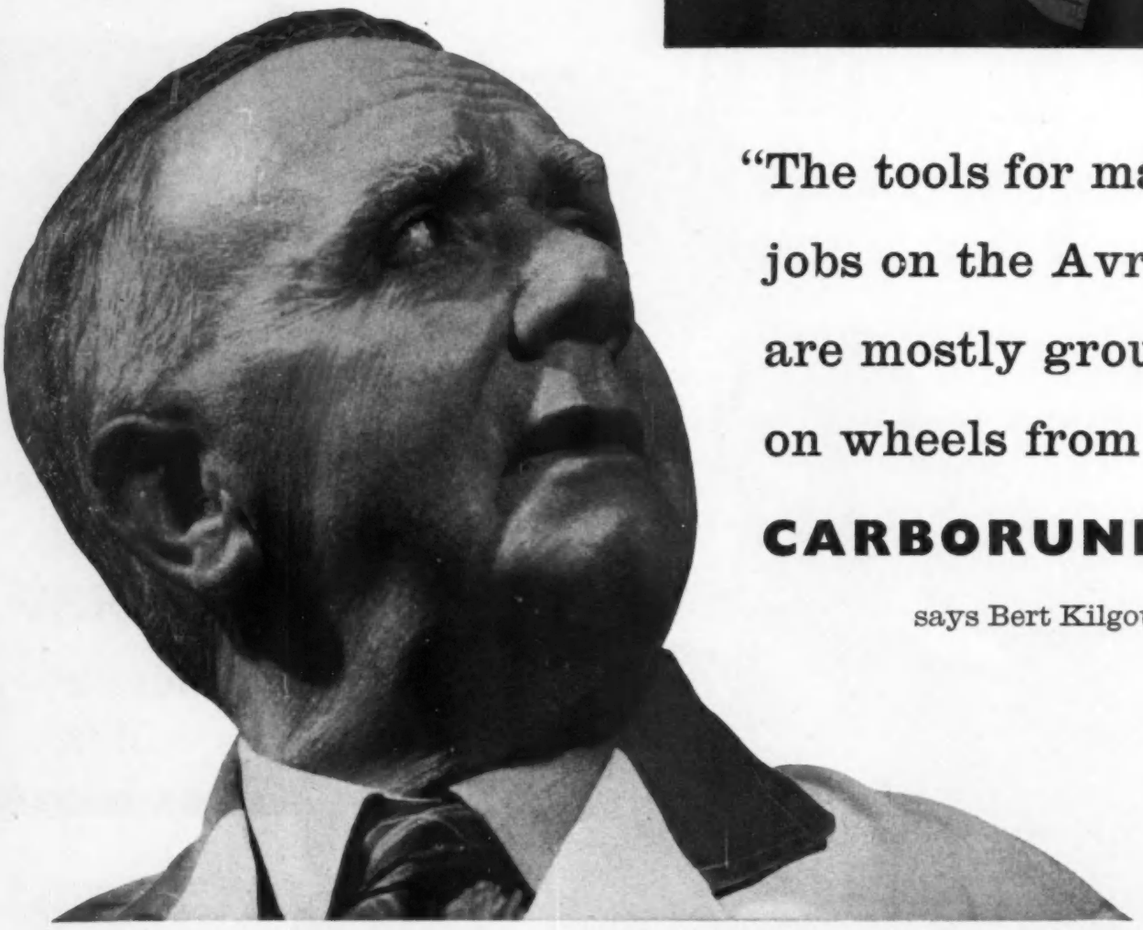
Bert Kilgour has worked at the main factory of A. V. Roe & Co. Ltd, at Chadderton, for 40 years, and is now the senior foreman of the toolroom, in which 300 men are employed: "Must be one of the biggest toolrooms in the country", Bert says. "We started getting grinding wheels from CARBORUNDUM in 1936, and they've supplied most of our wheels ever since then. That's for the whole factory—not just the toolroom. Why? Well, because their wheels do a good job, and give us good service. They've always been ready to help us when we've asked them to."





"The tools for machining jobs on the Avro Vulcan are mostly ground on wheels from CARBORUNDUM"

says Bert Kilgour

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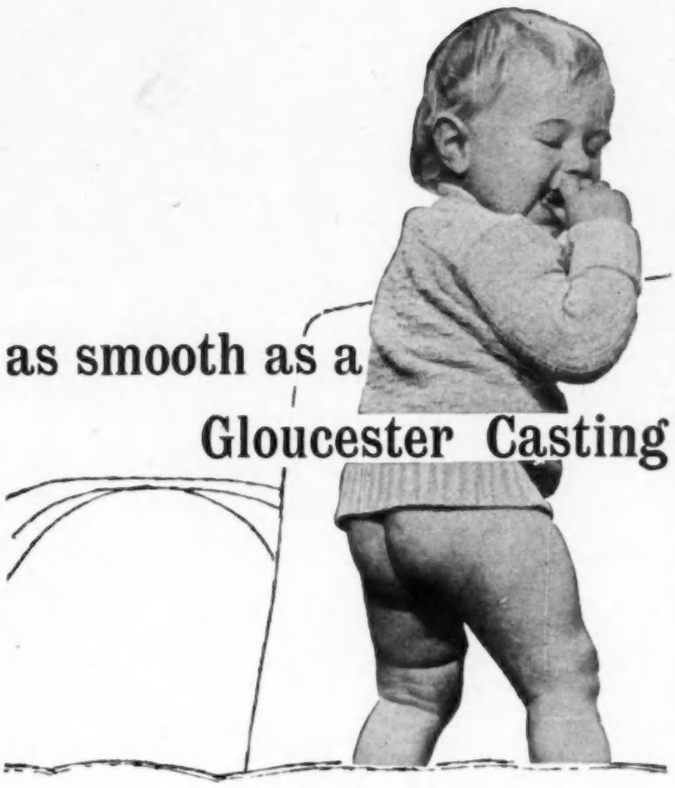


as smooth as a Gloucester Casting

The smoother and cleaner the casting the more accurately it fits into the machining jigs allowing saving of time during machining process. At Gloucester, Malleable iron castings are as clean as modern science and machines can make them.

Superb core making equipment, careful analysis of sand at every stage of the core making and moulding processes, the use of special mould and core dressings, ensure clean castings, even as they leave the "knock out" bay for final fettling.

The elevator type electric-furnace anneals in 48 hours instead of the usual 7 days. It also allows greater control of the casting during annealing, resulting in uniformity of metal, greater strength, and — a smoother, finer skin.

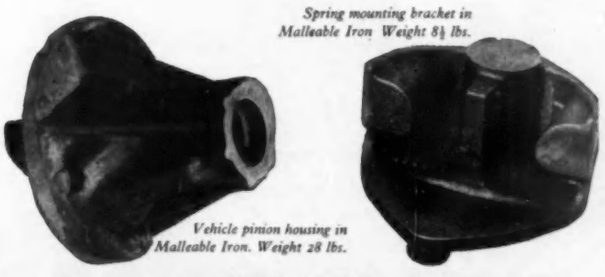
Gloucester can handle large runs of malleable castings for the automobile, railways, electrical and farming industries.

Gloucester are always willing to visit customers and help in the design of castings to save time and cost in production.

A typical Gloucester Malleable specification.

Gloucester Blackheart Malleable		*Gloucester Lamellar Pearlitic Malleable*	
Elongation	18%	Elongation	5%
Yield Point	12 tons	Yield Point	24 tons
Tensile Strength	25 tons psi	Tensile Strength	35 tons psi

Spring mounting bracket in Malleable Iron Weight 8¾ lbs.



Vehicle pinion housing in Malleable Iron. Weight 28 lbs.

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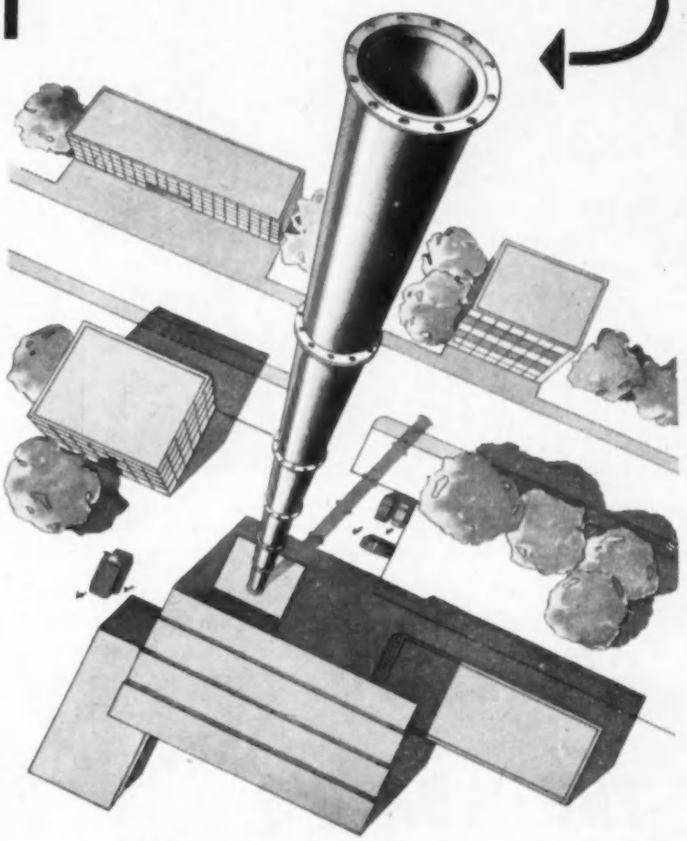
'DRIBORE'

The Logical Answer to Corrosion and Smut Emission Problems.



- Maintains inner surface above dew point of gases and stops condensation.
- Does not corrode and so lasts longer.
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- Made in flanged or socketed sections, it can be erected easily in the same way as normal steel chimney. No scaffolding is necessary.
- Construction is not confined to circular chimneys and can be used for square, rectangular or change section pieces, horizontal ducting and casings, etc.

A full description of this chimney appeared Page 322 in "The Engineer" dated 19 August 1960

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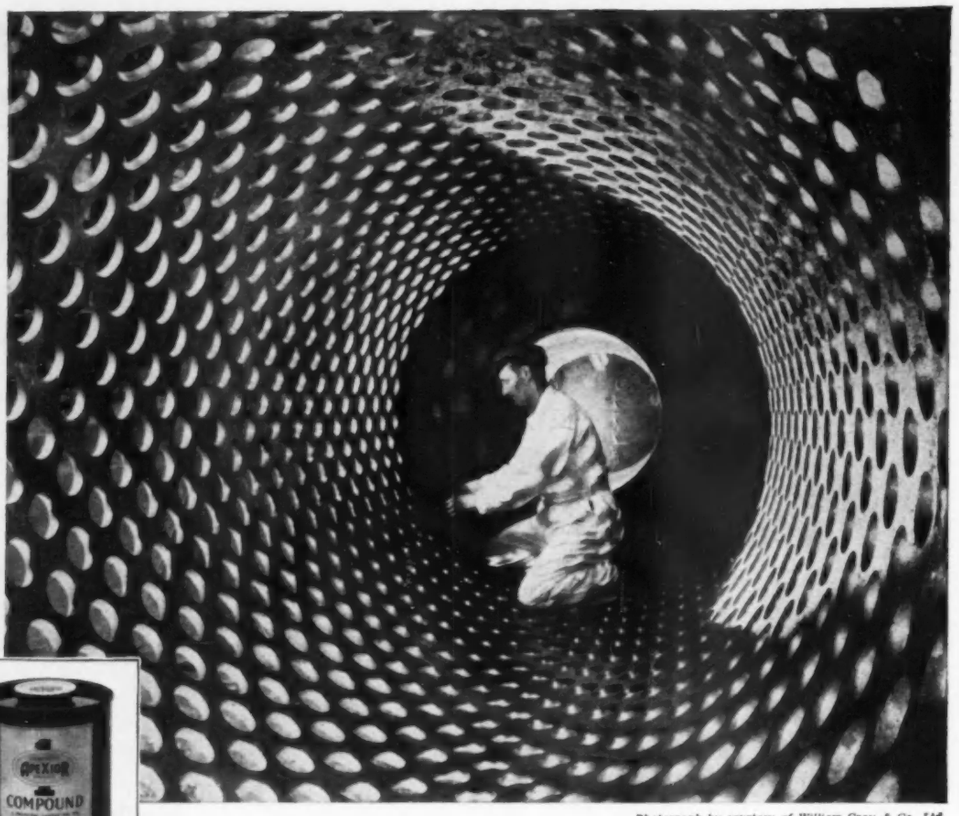

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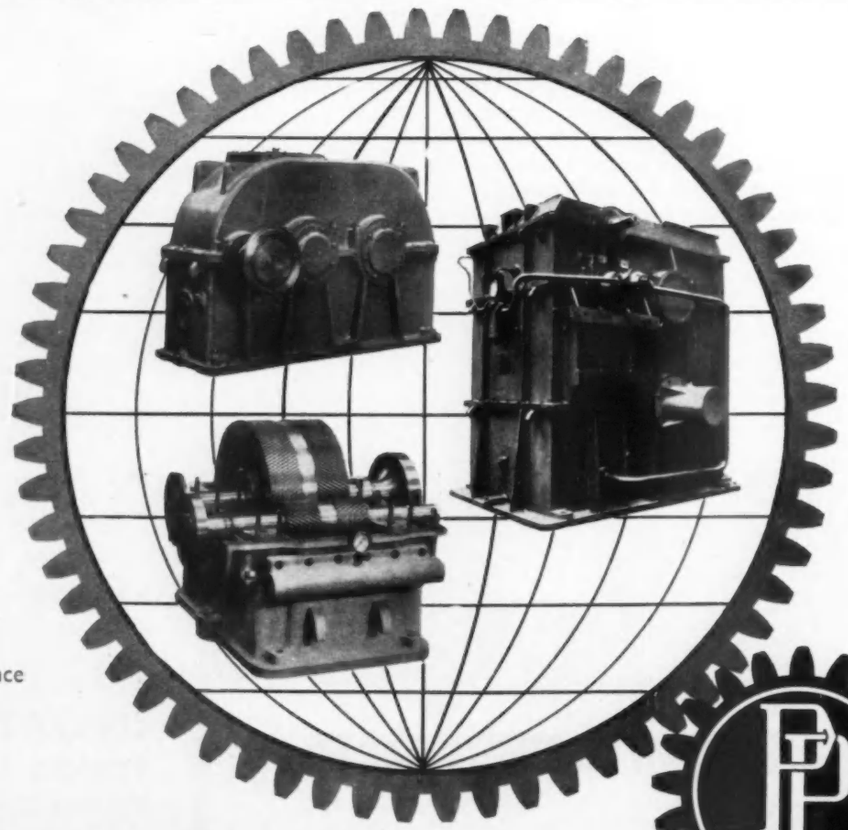

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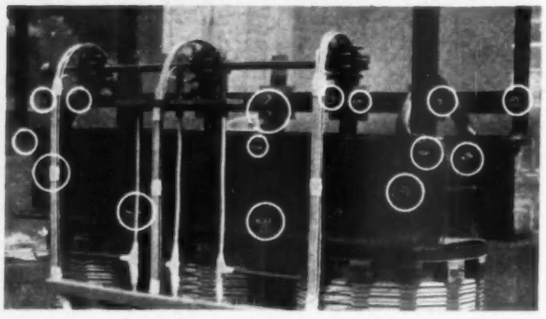

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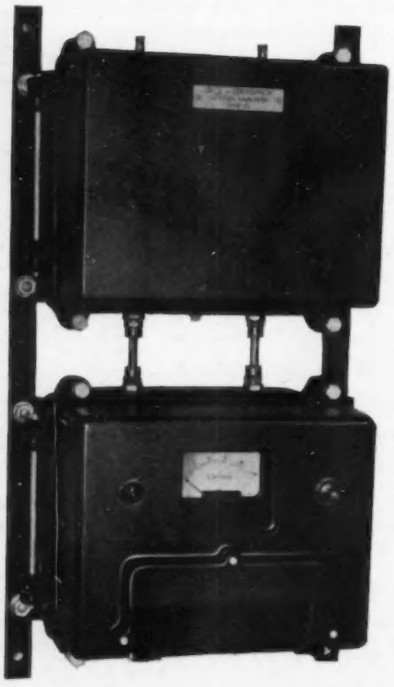

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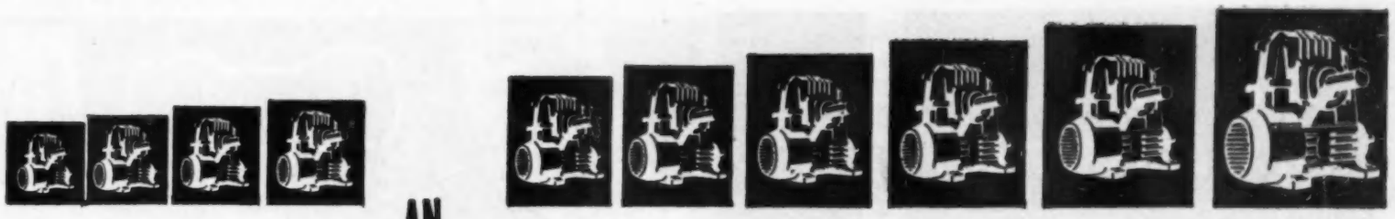

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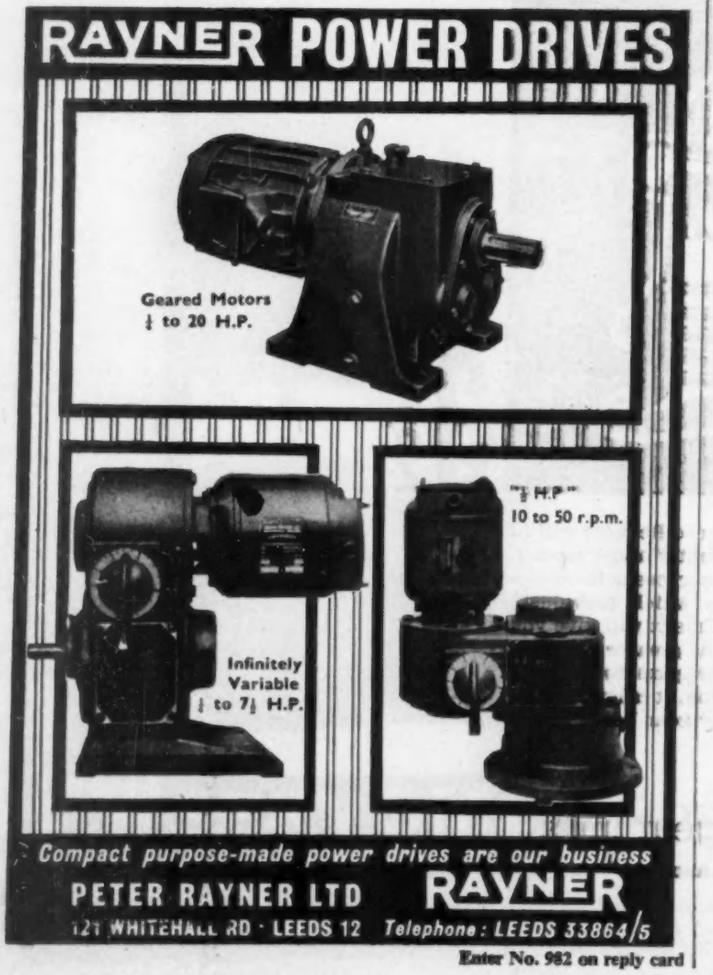

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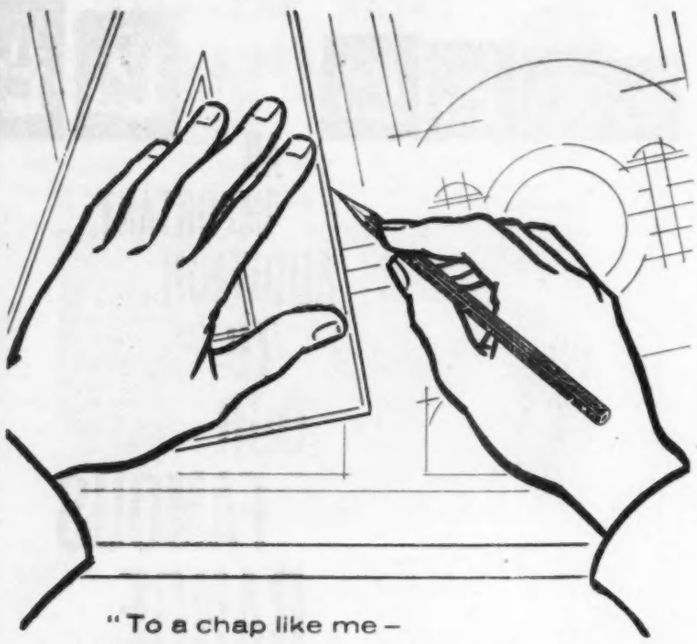

"To a chap like me—
and I'm proud of my work—my pencil's
my living.
The pencils I use have to stand up to fast
hard work, their grading's got to
be absolutely spot on—not almost
or nearly but bang on the dot every
time.
The leads must hold their points
and flow smoothly throughout a long line—
no crumbling or 'clinkers' mark you!—
and if I erase a line it must go cleanly—
there's no 'furrow' left in my paper
so you won't find ghost lines in prints
made off my drawings. As a matter of
fact you can tell from a print when it is
my drawing—the print's always first class."

"What pencils do I use?"

"Venus drawing pencils of course, the ones
with the crackle finish!—how else
do you think I keep up my high standard?"

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★ VENUS *Drawing Pencils are made in 17 accurate grades from 9H to 6B.*

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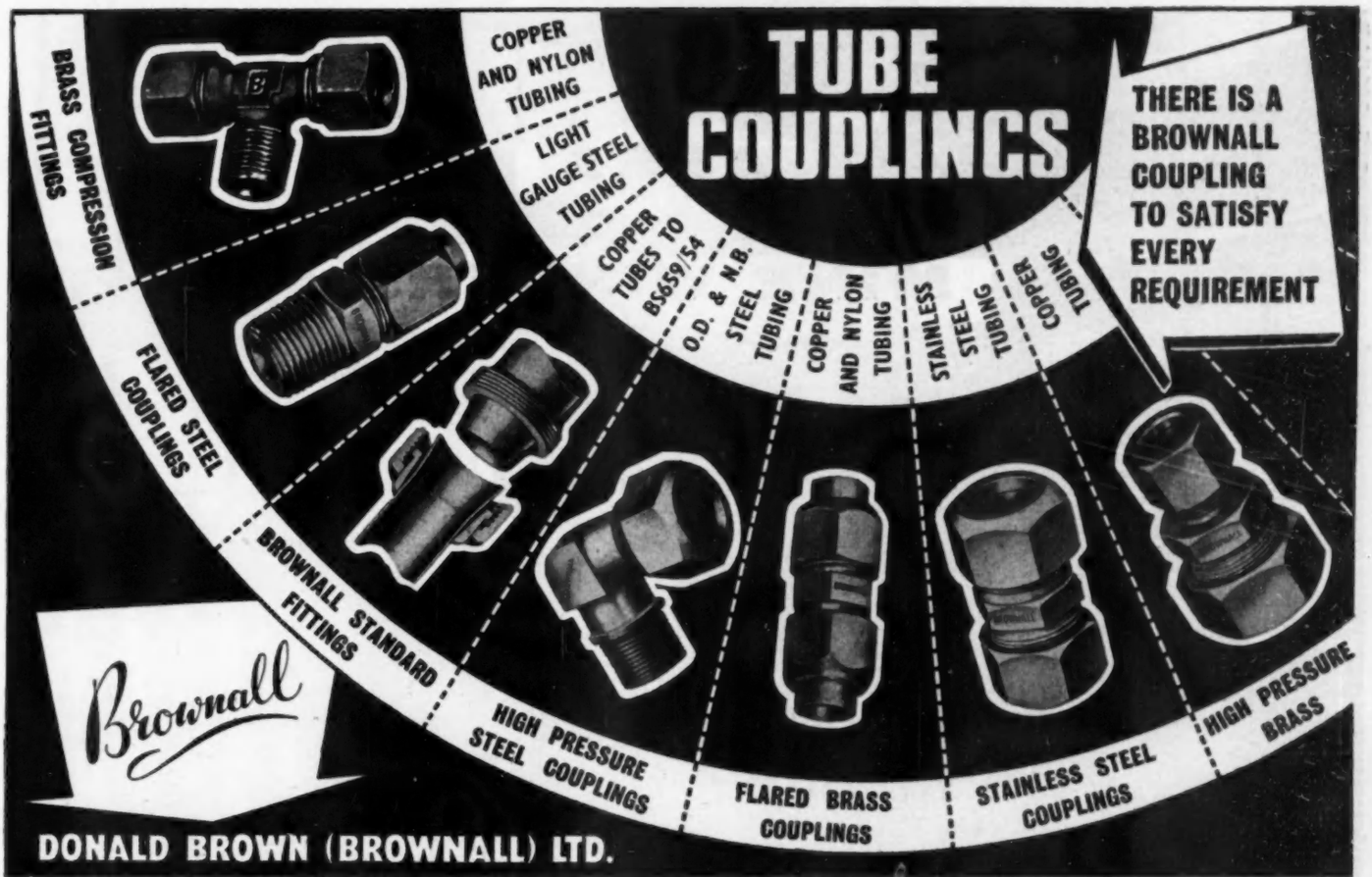

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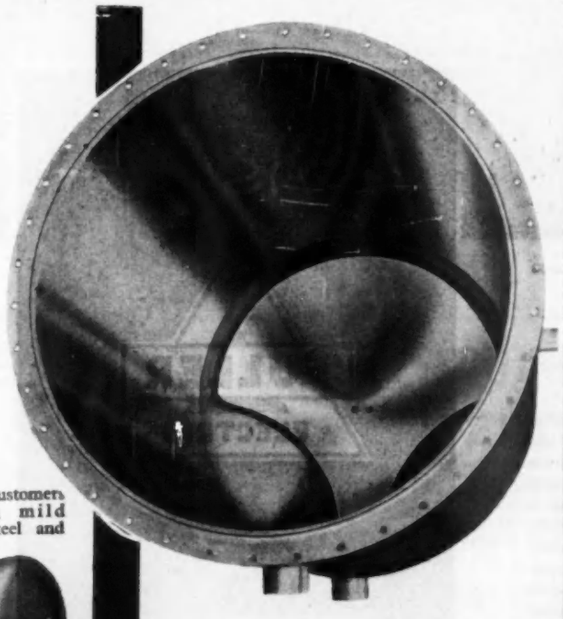

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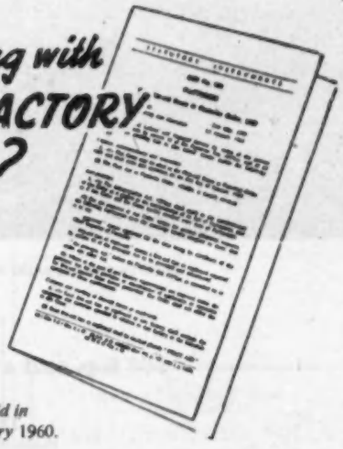

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Photo by courtesy of the National Coal Board, Scottish Division, East Fife area

900 h.p. and a rope speed of 30 ft. per second

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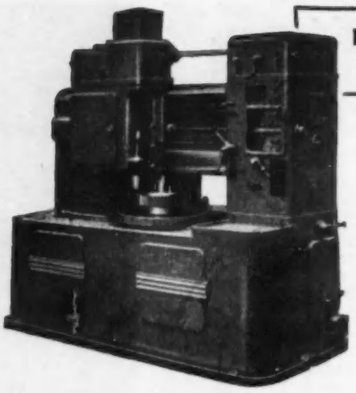
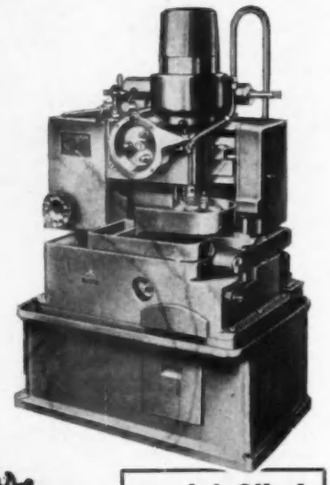
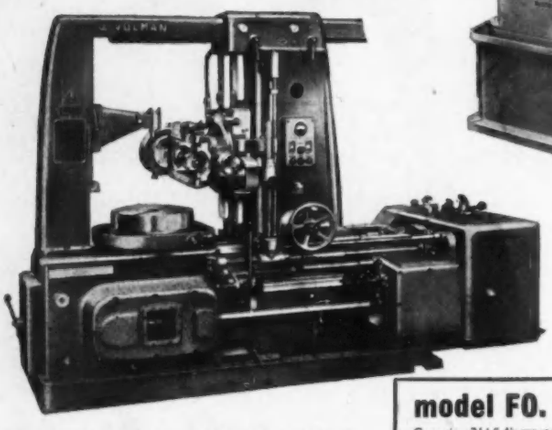


model OH. 6
Capacity external gears 17⅞"; internal gears 19⅝" x 6 mod.



model OH. 4
Gear Shaper, Capacity 7⅛" x 6 D.P.



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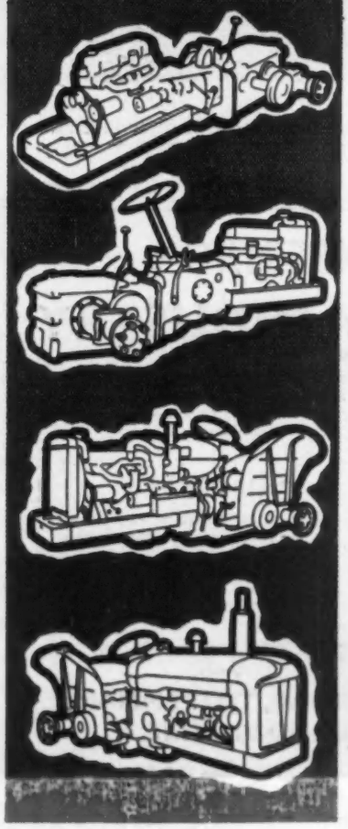

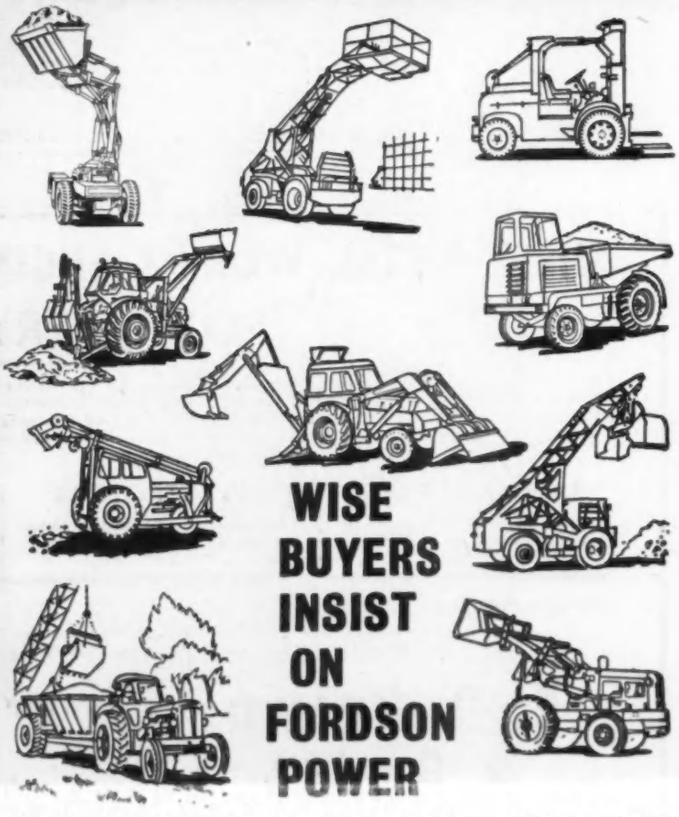

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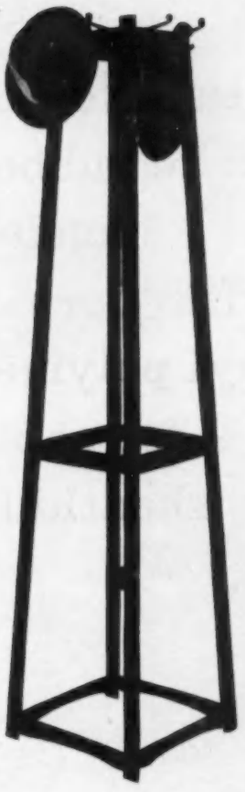

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....but is it easy to maintain?"

"It couldn't be easier—because there's nothing to maintain! With SPA all the usual maintenance factors are non-existent; dust abrasion has been eliminated, it is virtually self-cleaning and there are no moving parts to demand attention."

"But surely there must be something to do?"

"Well naturally you'll have to empty the collection hoppers."

"Is that all?"

"That's all. And remember—thanks to its complete adaptability, we can quickly supply a SPA installation built to your exact, individual requirements and still retain a very competitive price."

SPA

DUST EXTRACTION

A PRODUCT OF THE GAS CLEANING DIVISION OF

STEELS ENGINEERING INSTALLATIONS LIMITED Sunderland and Birmingham 713

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MINE WINDERS

Photo by courtesy of the National Coal Board, Scottish Division, East Fife area

900 h.p. and a rope speed of 30 ft. per second

This impressive ASEA 4-rope Friction Winder is installed at Seafield Colliery, East Fife area of the National Coal Board. It has A.C. motor drive of 900 h.p., speed 740 r.p.m., and uses a 6.6kV supply. A co-axial spring-mounted gear box is direct coupled to a 10 ft. diameter drum, giving a rope speed of 30 ft. per second. All ASEA Mine Winders incorporate closed-loop control as standard. On A.C. it operates through both dynamic and mechanical braking and fully compensates for load variations. Both Ward-Leonard and A.C. Winders are in successful operation in the U.K. with push-button control of mineral winding from both bank and insets.

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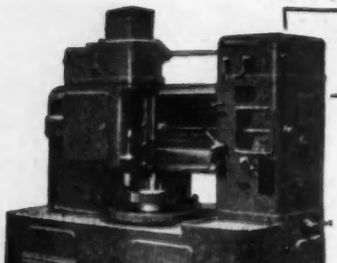
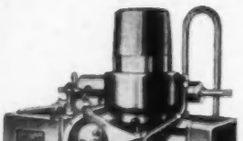
VOLMAN
GEAR HOBBERS &

model OH. 6
Capacity external gears 17⅜"; internal gears 19¼" x 6 mod.





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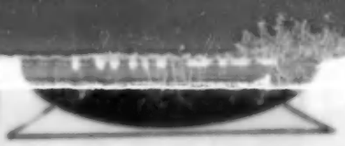

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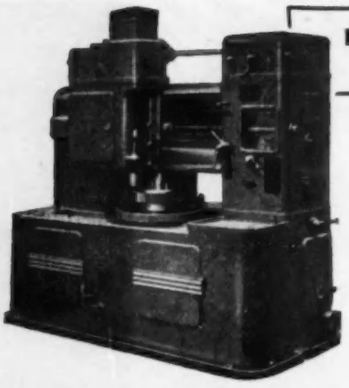
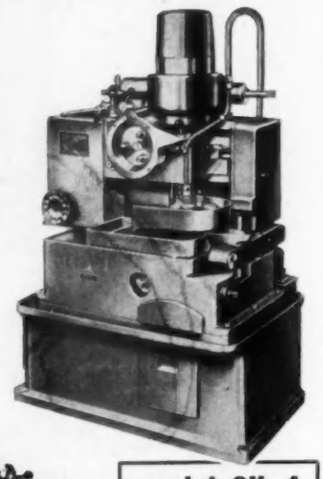
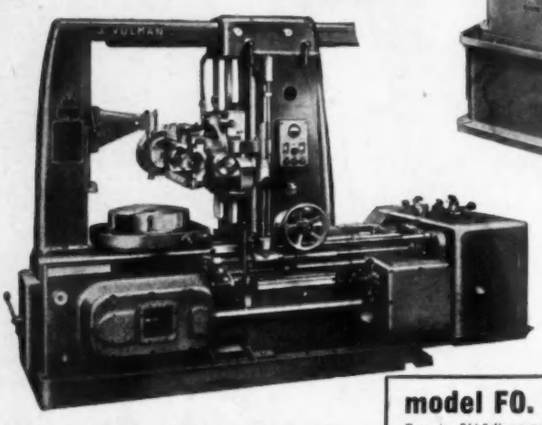


model OH. 6
Capacity external gears 17½"; internal gears 19½" x 6 mod.



model OH. 4
Gear Shaper, Capacity 7½" x 6 D.P.



model FO. 6
Capacity 31½" diameter x 4 D.P. Tangential Head available for cutting worm wheels.

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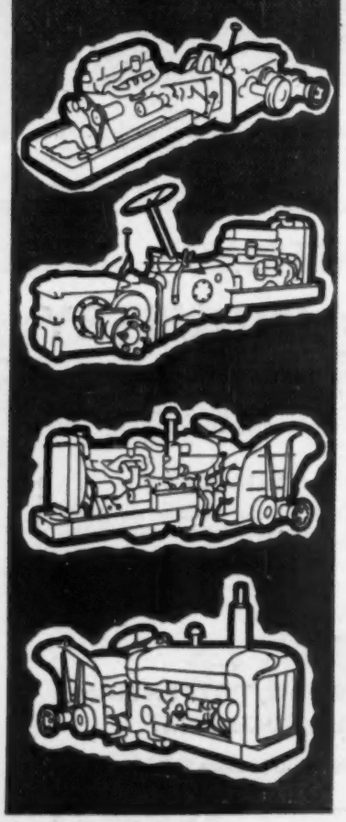

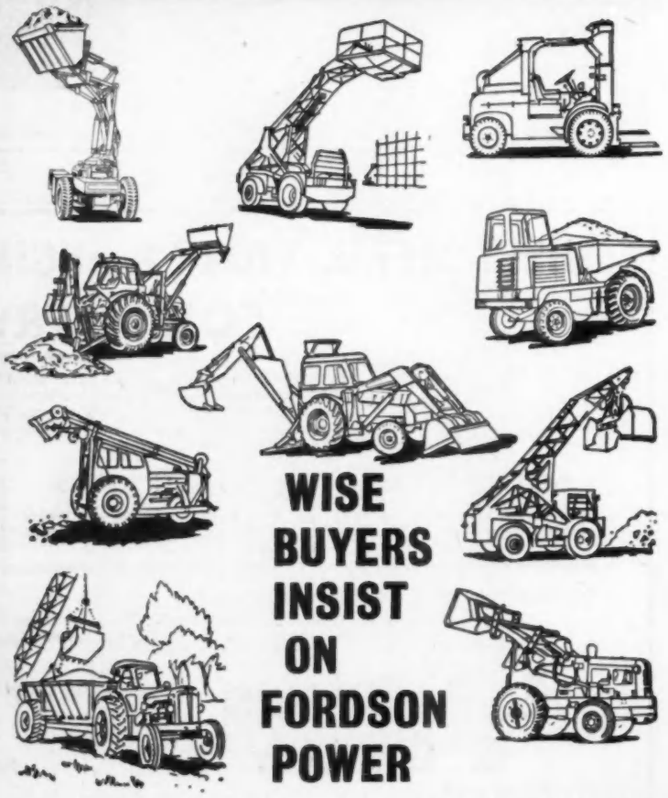

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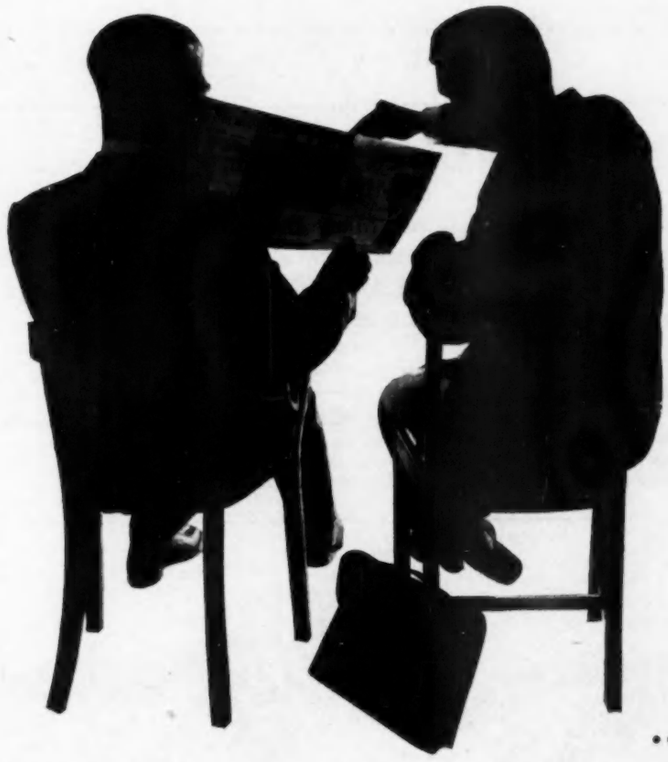
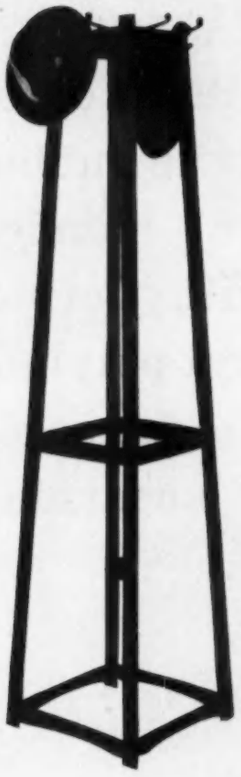
"YOU SAY THAT SPA HAS UNEQUALLED COLLECTING EFFICIENCY...





SPA is a unique, dry, centrifugal dust collector embodying the latest principle of dust extraction: Selective Particle Acceleration. This principle, whereby dust particles are removed **before** they cause wear, promotes higher collection efficiency, lower power consumption and longer life.

.... but is it easy to maintain?"

"It couldn't be easier—because there's nothing to maintain! With SPA all the usual maintenance factors are non-existent; dust abrasion has been eliminated, it is virtually self-cleaning and there are no moving parts to demand attention."

"But surely there must be something to do?"

"Well naturally you'll have to empty the collection hoppers."

"Is that all?"

"That's all. And remember—thanks to its complete adaptability, we can quickly supply a SPA installation built to your exact, individual requirements and still retain a very competitive price."

SPA

DUST EXTRACTION

A PRODUCT OF THE GAS CLEANING DIVISION OF

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'Butakon' A nitrile rubber blended with 'Corvic' vinyl polymer for cable sheathing

BLENDS OF 'BUTAKON' A WITH 'CORVIC' HAVE THE FOLLOWING PROPERTIES:—

* **ABRASION RESISTANCE**
  0.18 c.c/hr. (B.S. 903: 1950 du Pont method)
* **OIL RESISTANCE**
  —12.4% in A.S.T.M. No. 1 oil
  +0.29% in A.S.T.M. No. 3 oil
* **FLAME RESISTANCE**
  immediately extinguished (B.S. 2848 App. K)
* **OZONE RESISTANCE**
  Resists 1% concentration of ozone
* **WEATHERING RESISTANCE**
  Samples exposed for 6 months in India unaffected
* **WIDE COLOUR POSSIBILITIES**
  for easy identification

N.B. The figures given are for a particular compound but are indicative of the results normally obtained

The Hackbridge Cable Co. Ltd., have made use of these properties in the manufacture of their 'Kelvinex' sheathed cable made from a 'Butakon' A/'Corvic' blend. Many thousands of yards of 'Kelvinex' mines trailing and drilling cables are already in service in British Coal Mines. The compound used in sheathing these cables meets the physical test and ageing requirements of B.S.2899.

'BUTAKON'	'CORVIC'	'KELVINEX'
is the registered trade mark for the range of butadiene copolymers manufactured by I.C.I.	*is the registered trade mark for the vinyl polymers manufactured by I.C.I.*	*is the trade name of the 'Butakon' A/'Corvic' blend sheathed cable made by Hackbridge Cable Co. Ltd.*

Loading 'Kelvinex' sheathed cable at Hackbridge Cable Co. Ltd., Kelvin Works, Hackbridge, Surrey, for delivery to the mine.

PB37

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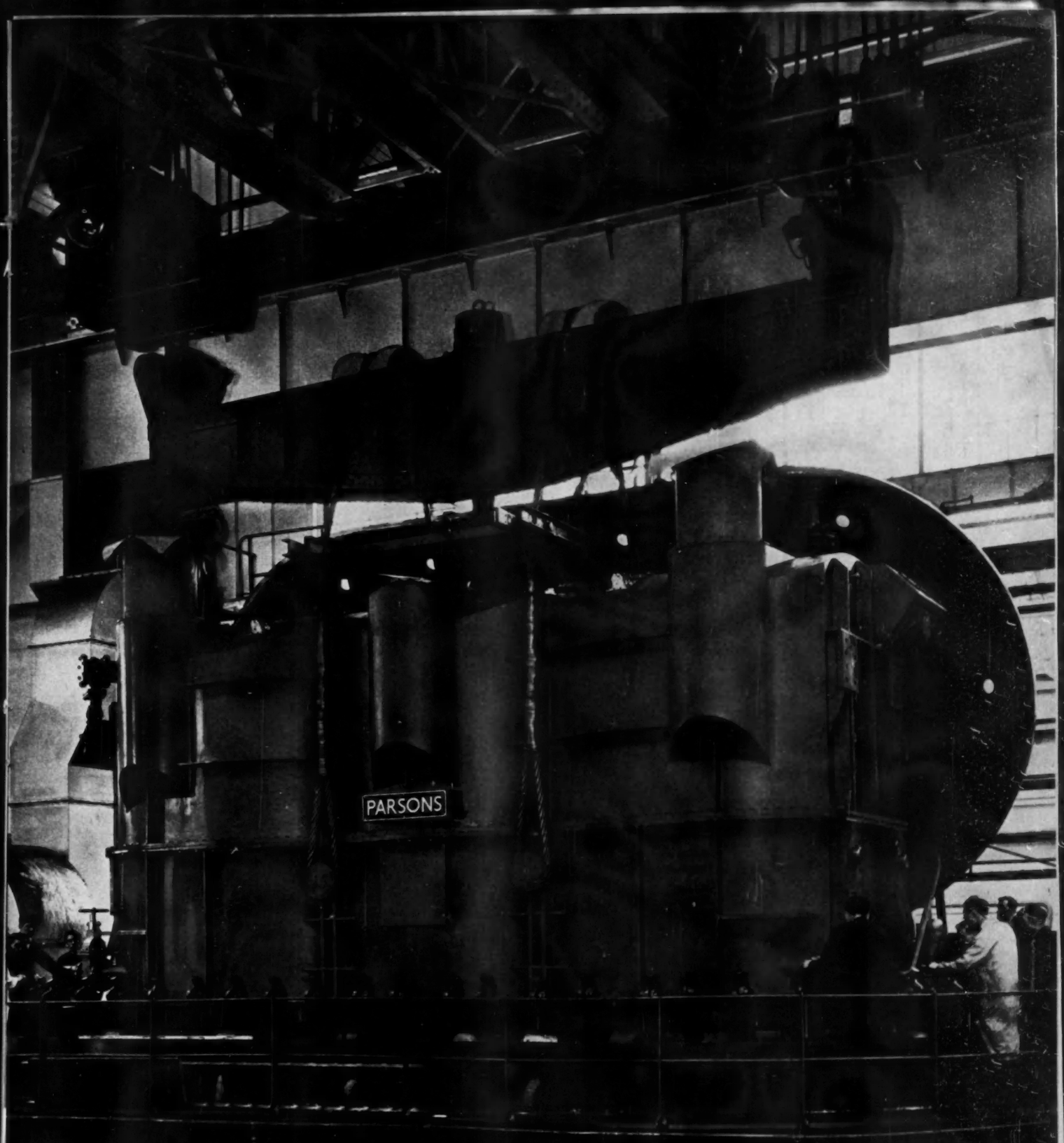

A PARSONS 180 MVA 275/132 kV auto transformer weighing 146 tons lifted after drying out process, from an autoclave at Heaton Works.
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SWEDISH LADDER

New drifting technique doubles drill-crew output

Controlled feed · guided collaring · mechanical retraction— so one man can operate two rigs

NORTHERN SWEDEN has been the proving ground of a revolutionary rock drilling method which has opened the way to a completely new conception of drill-crew output. Known as the Swedish Ladder Drilling Method, this new technique has been employed on hydro-electric projects at Korsselbränna and Stalon where drilling platforms with 16 rock drills operated by 8-man drill crews have been used.

Atlas Copco drills mounted on retractable pusher legs* are rested in cradles running horizontally in "ladders". Contractors and drill crews have found that these rigs, cheaply and simply constructed, offer the following advantages:

INCREASED PENETRATION—full feed power is ensured by the ideal horizontal feeding position of the pusher leg.

HIGHER OUTPUT PER MAN/HOUR—due to greater penetration and the fact that *one man handles two drills.*

REDUCED CREW FATIGUE—collaring is made simple as operators need not hold the drills. Drill steels are mechanically withdrawn from holes using the retractable pusher leg.

FEWER DRILL STEEL CHANGES—long steels can be used from the start. For greater durability 1″ Sandvik Coromant integral steels are used.

GREATER DRILLING ACCURACY—thanks to the fixed ladder base and pre-positioning of drills for pattern drilling.

DRILLING METHOD

DRAMATIC RESULTS OF LADDER DRILL TESTS

The figures show the dramatic increase in drilling achieved by ladder rigs in a 60 sq.m. tunnel at Stalon driven in hard-drilled quartzite. Gross effect refers to the mean value for the whole drilling period, including collaring, changing steels and the usual routine delays. *Note that the gross effect is exactly doubled.*

GROSS EFFECTS

[redacted]

19.5 metres/man-hour Conventional drilling with one rock drill.

[redacted]

39.0 metres/man-hour Ladder drilling with two drills.

Available from Atlas Copco. The Swedish Ladder Drilling Method was originally introduced by Widmark and Platzer, one of Sweden's leading contracting companies, and has been further developed by them and by the Swedish State Power Board. Specially evolved with Atlas Copco trigger-operated retractable pusher legs*, this method and equipment has been exhaustively tested and proved under tough Swedish drilling conditions. There are Atlas Copco companies or agents in ninety countries and details of the new equipment are readily available from them or from the address below. Wherever you are, the international Atlas Copco group offers expert advice on the selection of equipment and complete after-sales service.

WRITE FOR THE BOOKLET! The Swedish Ladder Drilling Method is described in greater detail in a new Atlas Copco booklet. Write for a copy to your local Atlas Copco company or agent or from the address below.

* Patents pending

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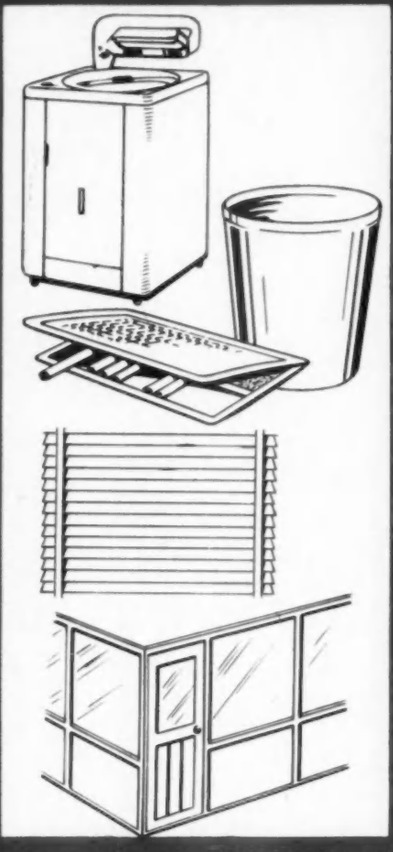

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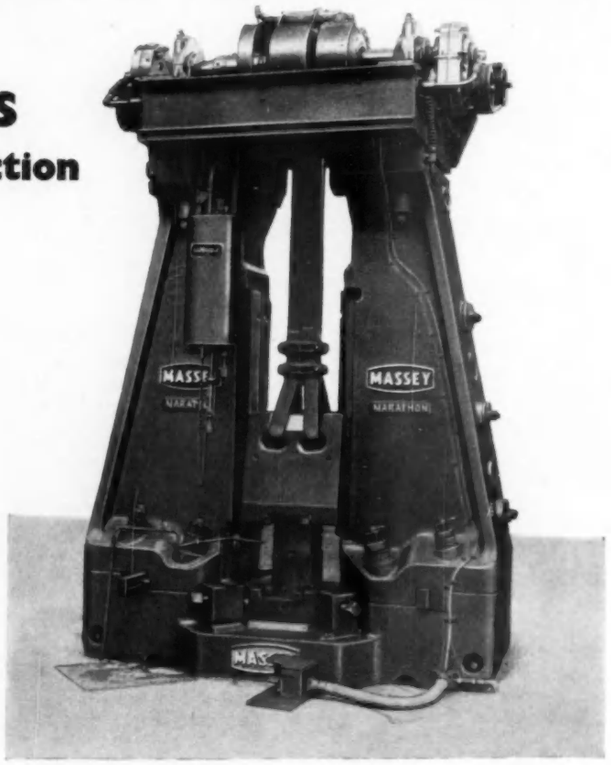
for high speed production of intricate forgings

Specially designed for high speed production of intricate forgings, Massey Marathon Drop Hammers have compressed air control for easier operation. Electrical drive ensures low upkeep costs and the design of the slides and standards makes accurate die alignment easy.
Important design features include fully automatic control for any length of blow and the lifter is insulated from shock for longer life.
Available in sizes from 10 cwt. to 40 cwt.



20 cwt. Marathon Drop Hammer in our own forge.

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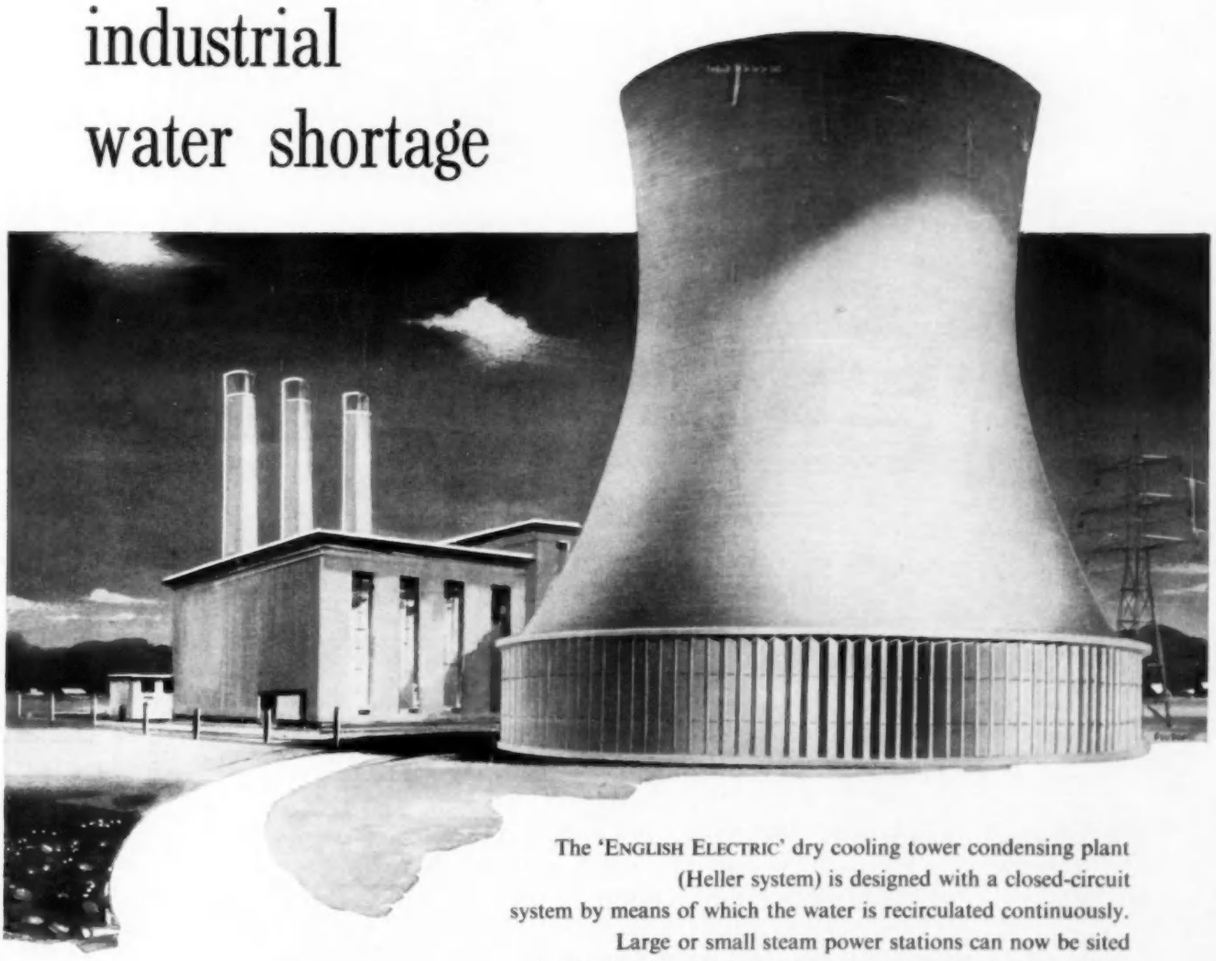
DRY cooling tower installations overcome industrial water shortage



The 'ENGLISH ELECTRIC' dry cooling tower condensing plant (Heller system) is designed with a closed-circuit system by means of which the water is recirculated continuously. Large or small steam power stations can now be sited independently of large sources of water for condenser cooling.

A publication "Dry Cooling Tower Condensing Plant" is available on application to The English Electric Co. Ltd., Steam Turbine Division, Rugby.

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Important design features include fully automatic control for any length of blow and the lifter is insulated from shock for longer life.
Available in sizes from 10 cwt. to 40 cwt.

20 cwt. Marathon Drop Hammer in our own forge.

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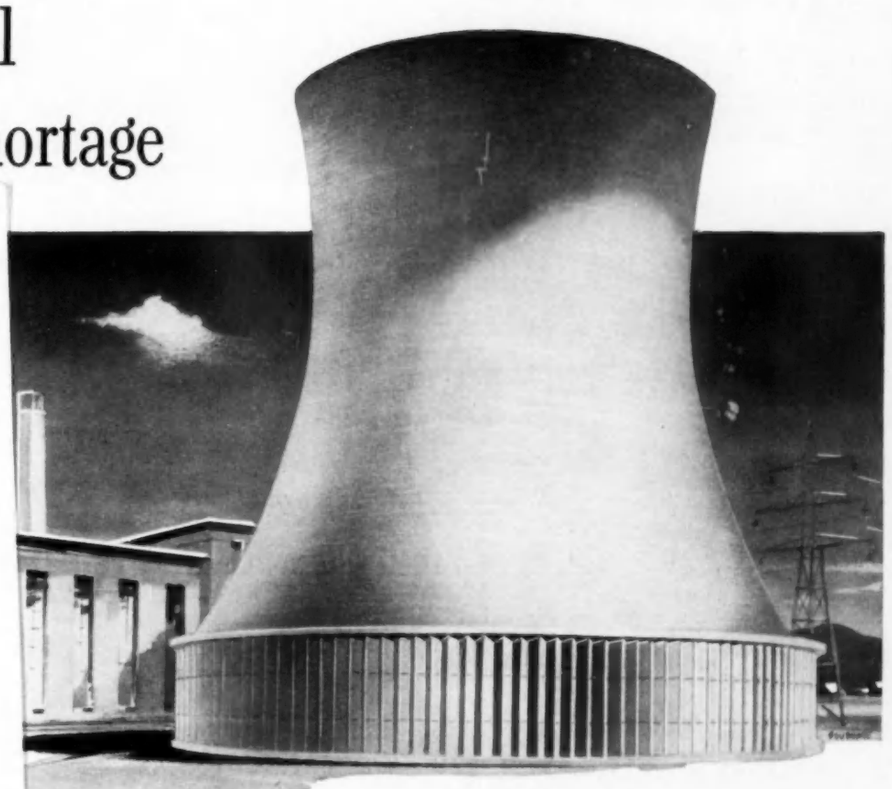

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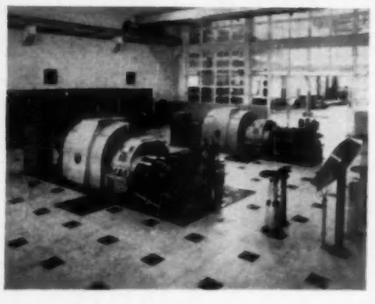
20,000 kW Radial Flow Steam Turbines installed for the Central Electricity Generating Board, York.



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1500 kW Back Pressure Axial Flow Steam Turbines installed for the Sugar Industry, Mauritius.

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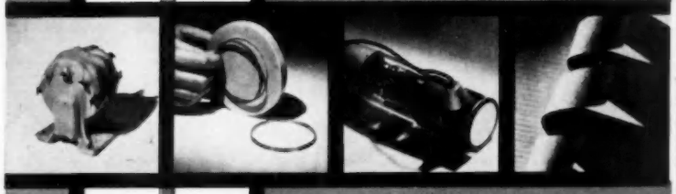

'Silcoset' rubbers may be just what you've been waiting for—find out more about them. Write for the illustrated brochure—'Silcoset' Silicone Rubbers—to your nearest I.C.I. Sales Office or to

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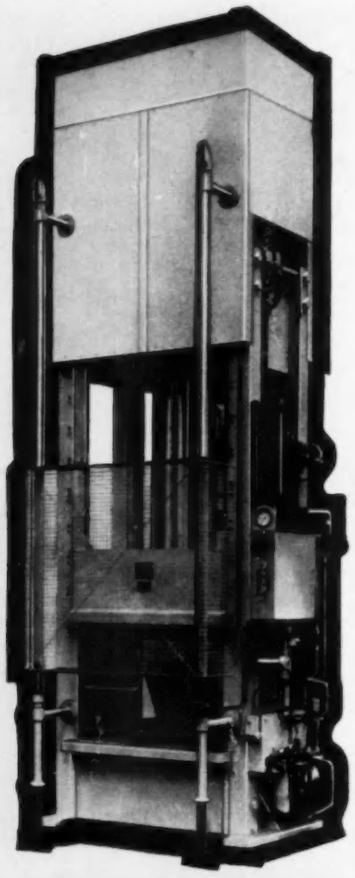

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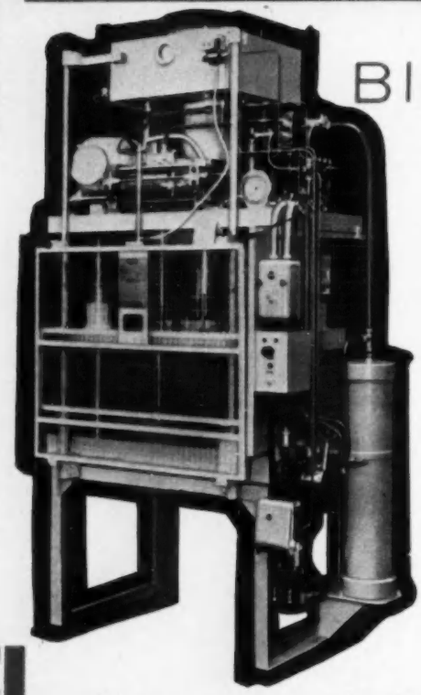

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This entirely new downstroking 30 ton BIPEL hydraulic flash clipping press has all the advantages of accurate semi-automatic operation. It is fast and safe to operate. Pressure range 10, 20 or 30 tons.

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128 Oct. 14, 1960 THE ENGINEER

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An ugly word.
You could whistle through your teeth at it.
The world is full of fabricators.

What the world needs today are *complete fabricators.*
Not many of *them* around.

As it happens
A number of such fabricators
Are assembled at Plowright Brothers

Awaiting your orders
To fabricate completely
Anything from a biological shield
To a furnace track creeper,
Or (if you prefer),
From London Bridge
To Popacatapetl *

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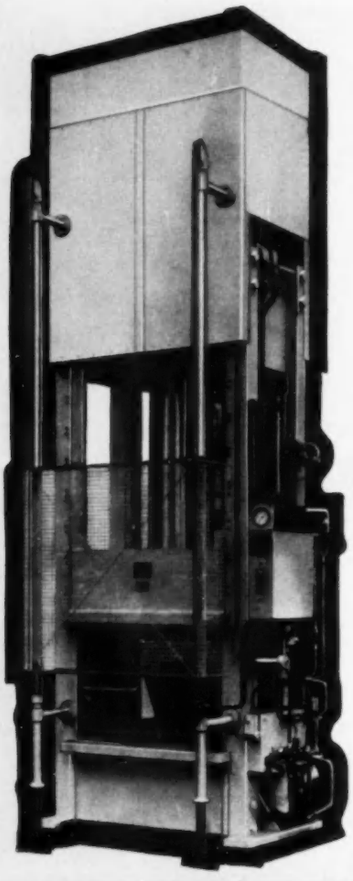
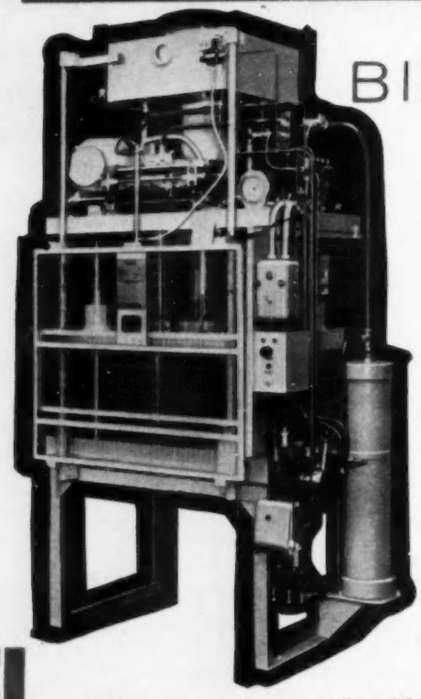


BIPEL 250 TON SEMI-AUTOMATIC BATTERY BOX MOULDING PRESS

Features of [illegible] its large tab[illegible] long stroke[illegible] in operation[illegible] made to su[illegible]

HYDRAULICALLY OPERATED MACHIN[illegible]



BIPEL SEMI-A[illegible] DIE CA[illegible] FLASH[illegible]

This entir[illegible] BIPEL hy[illegible] has all the advantages of accurate semi-automatic operation. It is fast and safe to operate. Pressure range 10, 20 or 30 tons.

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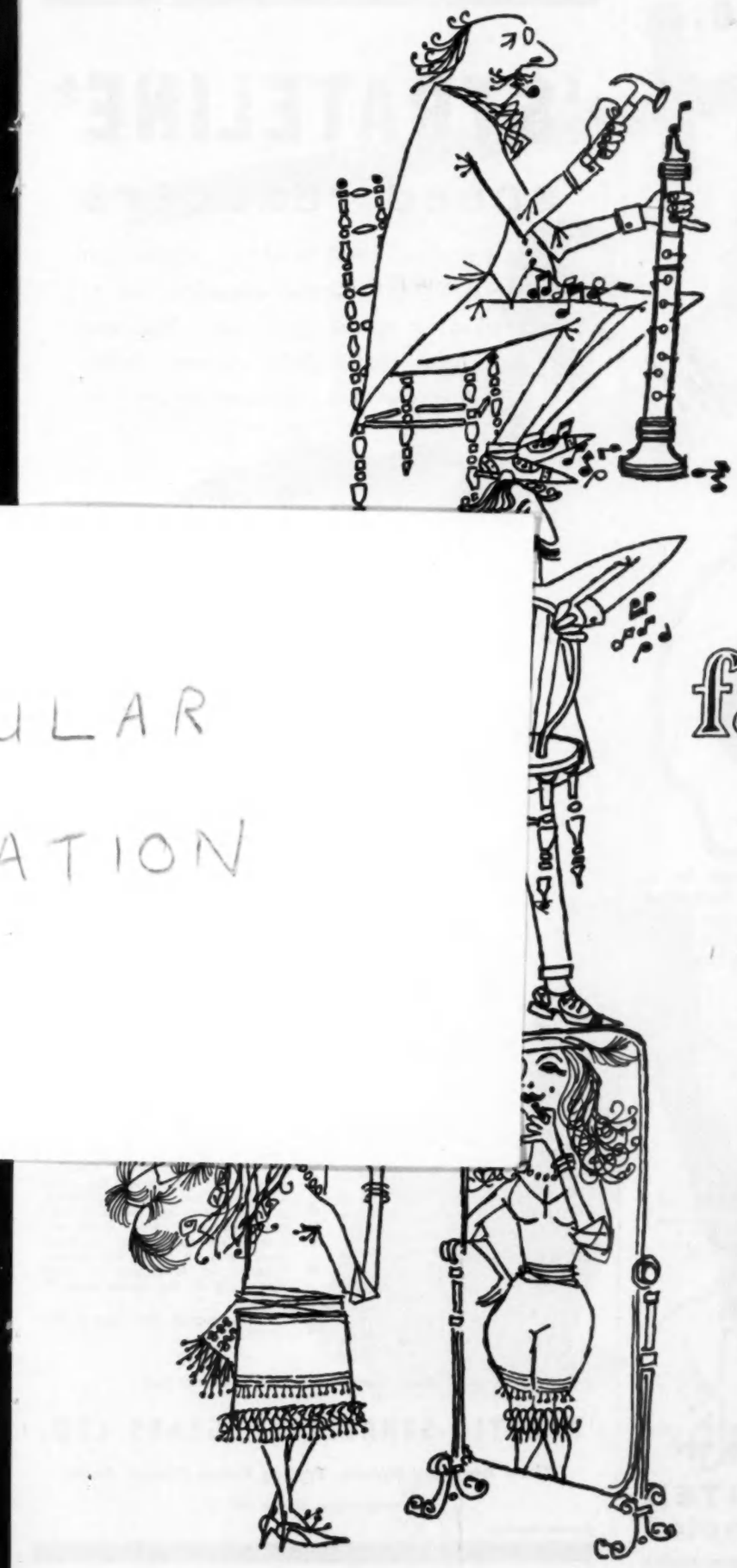
PAGINA[illegible]



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Awaiting your orders
To fabricate completely
Anything from a biological shield
To a furnace track creeper,
Or (if you prefer),
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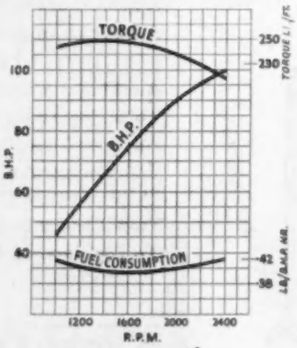

Meadows 4 DC 330 series Diesel Engine

4 Cylinders 120 mm Bore

120 mm Stroke 5.43 Litres (331 cu. in.)

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LIGHTER

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Radio and Electronic Components Division
Lamps and Lighting Department,
38/39 Upper Thames Street, London, E.C.4
CEC 11/79

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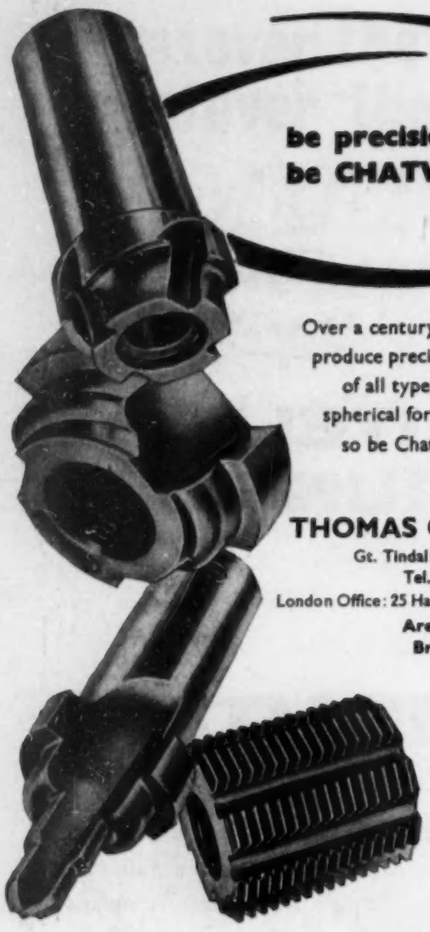

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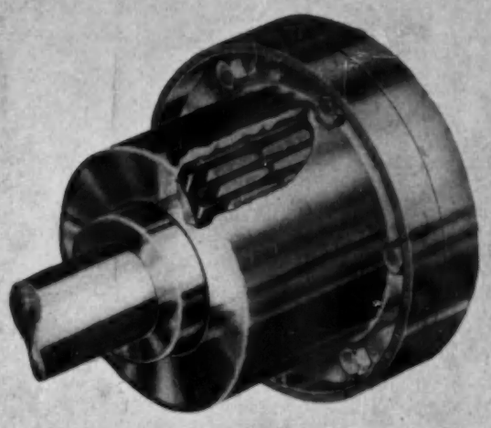

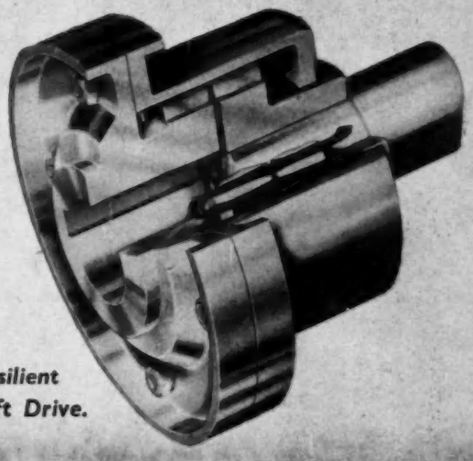

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Firms and Organisations like Shell, I.C.I., British Railways, The National Coal Board, etc., find this the perfect Fitting for mending and joining rubber hose of all diameters. You simply fit hose ends over the nozzles and hammer the Claw-Grips home. A "HERCULES" Repairer — and a hammer—is a complete Hose mending outfit, and is only one in the low-cost, efficiency range of "HERCULES" Fittings. *Have us send you full details and prices.*

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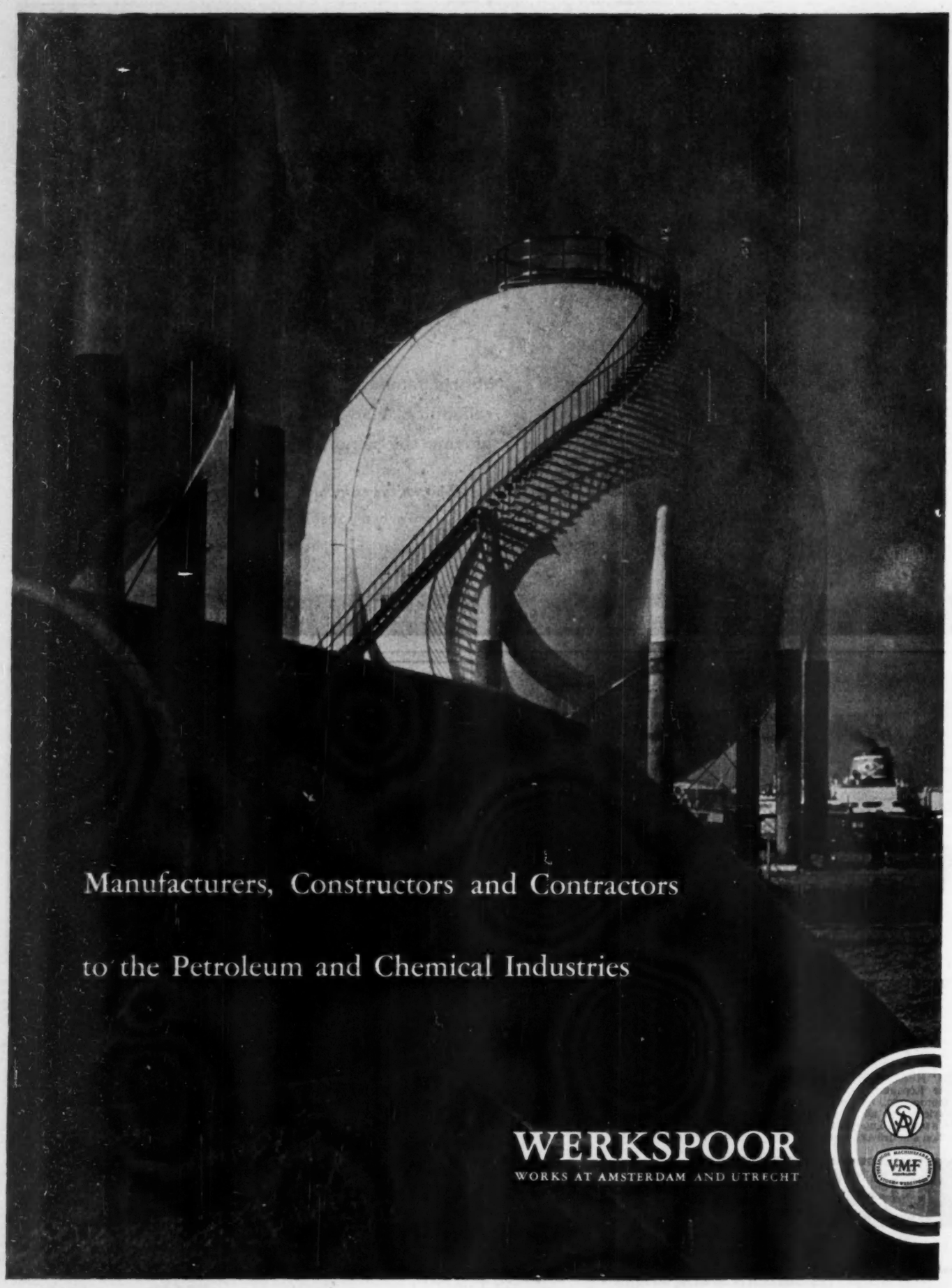

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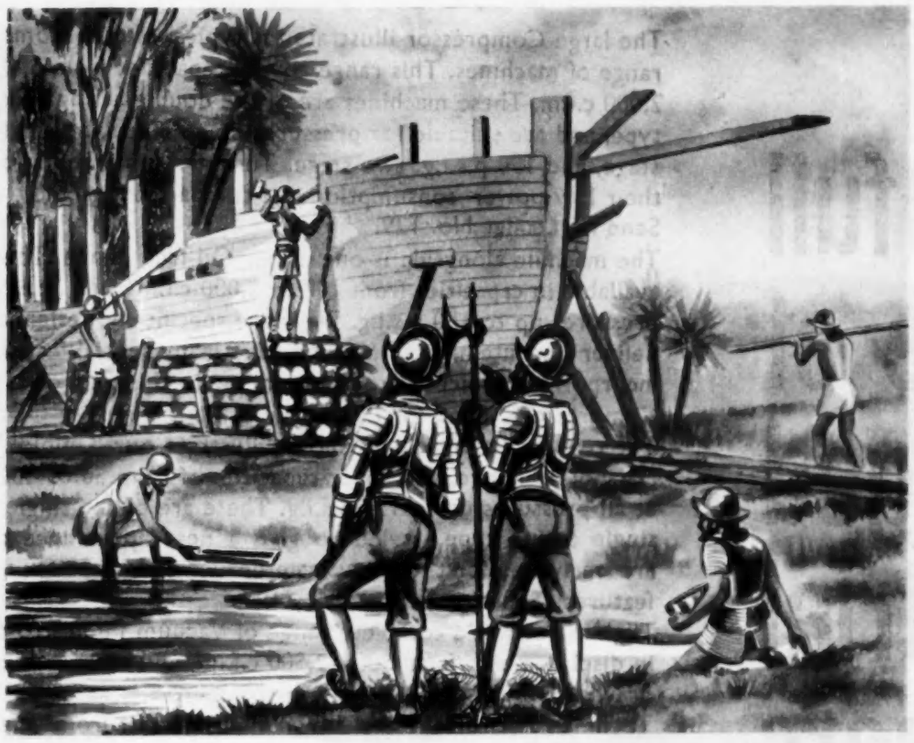

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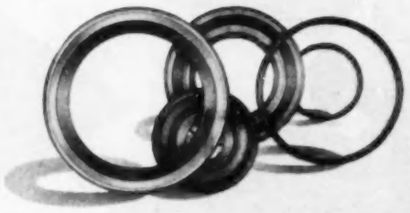

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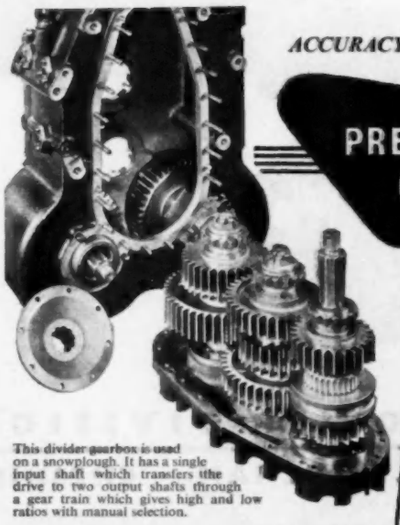

This divider gearbox is used on a snowplough. It has a single input shaft which transfers the drive to two output shafts through a gear train which gives high and low ratios with manual selection.

3 versions of this box are used on "Michigan" Tractor Shovels. It has 4 forward and 4 reverse gears with manual high-low range selection. 2 or 4-wheel drive can be selected by manual control. Since production started in 1958 this box has proved completely trouble-free under the most arduous conditions.

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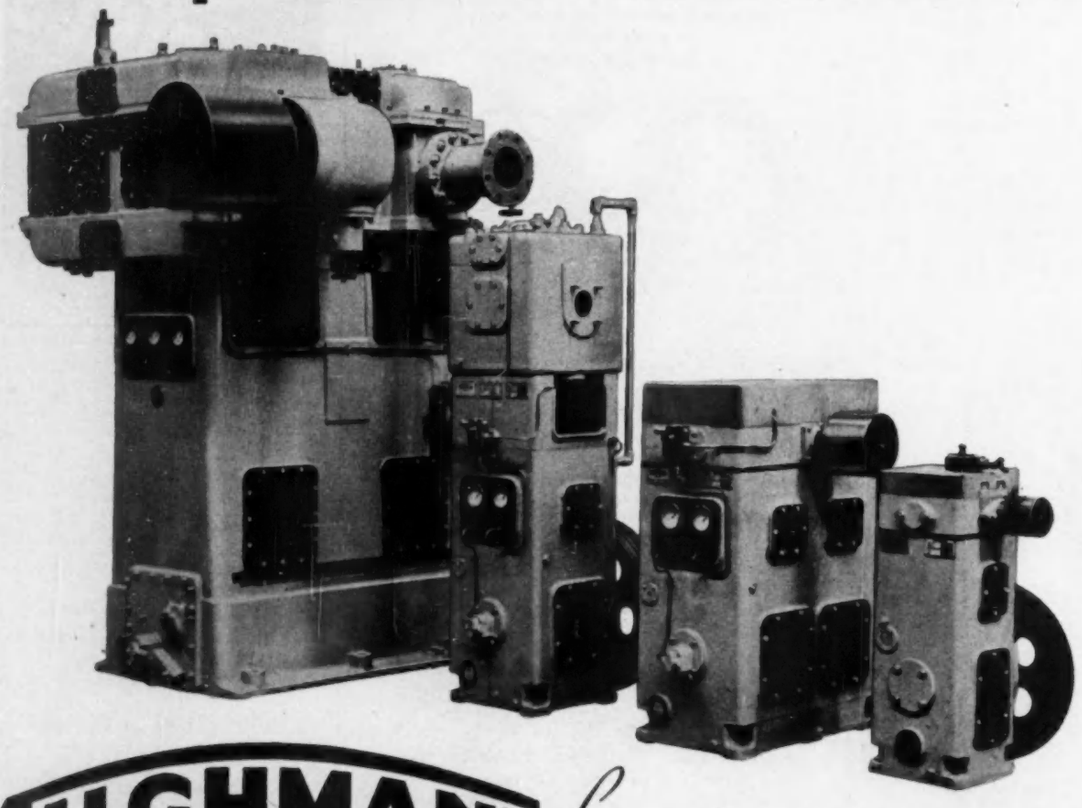
Tilghman's undertake the design and manufacture of special purpose Air & Gas Compressors, Boosters, etc., and welcome an opportunity of quoting for complete installations.



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TILGHMAN'S *limited* **AIR POWER DIVISION**

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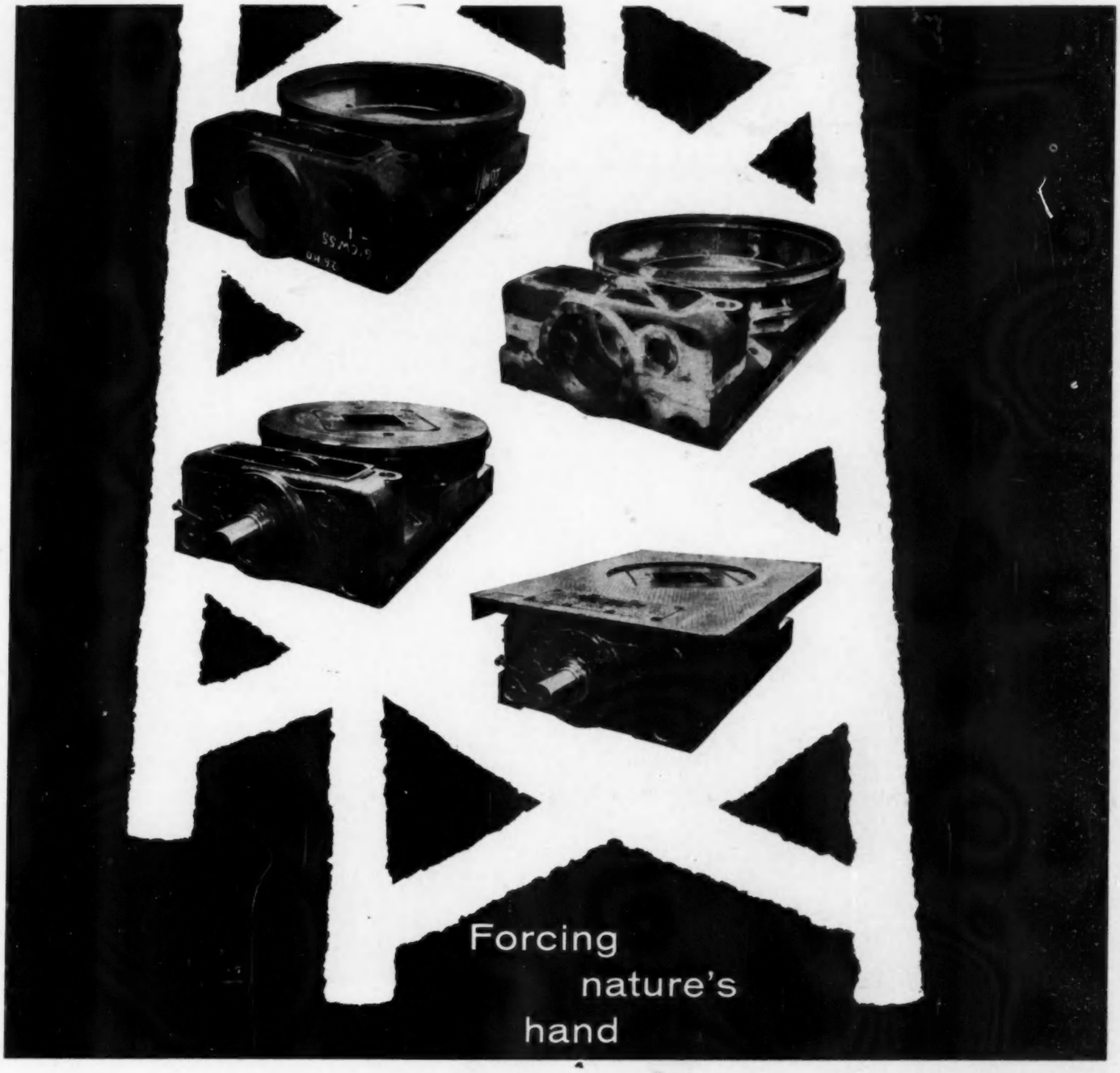

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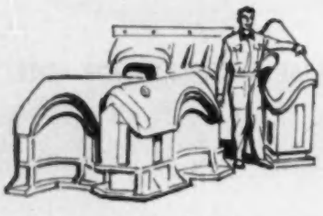

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from 3″ size upwards

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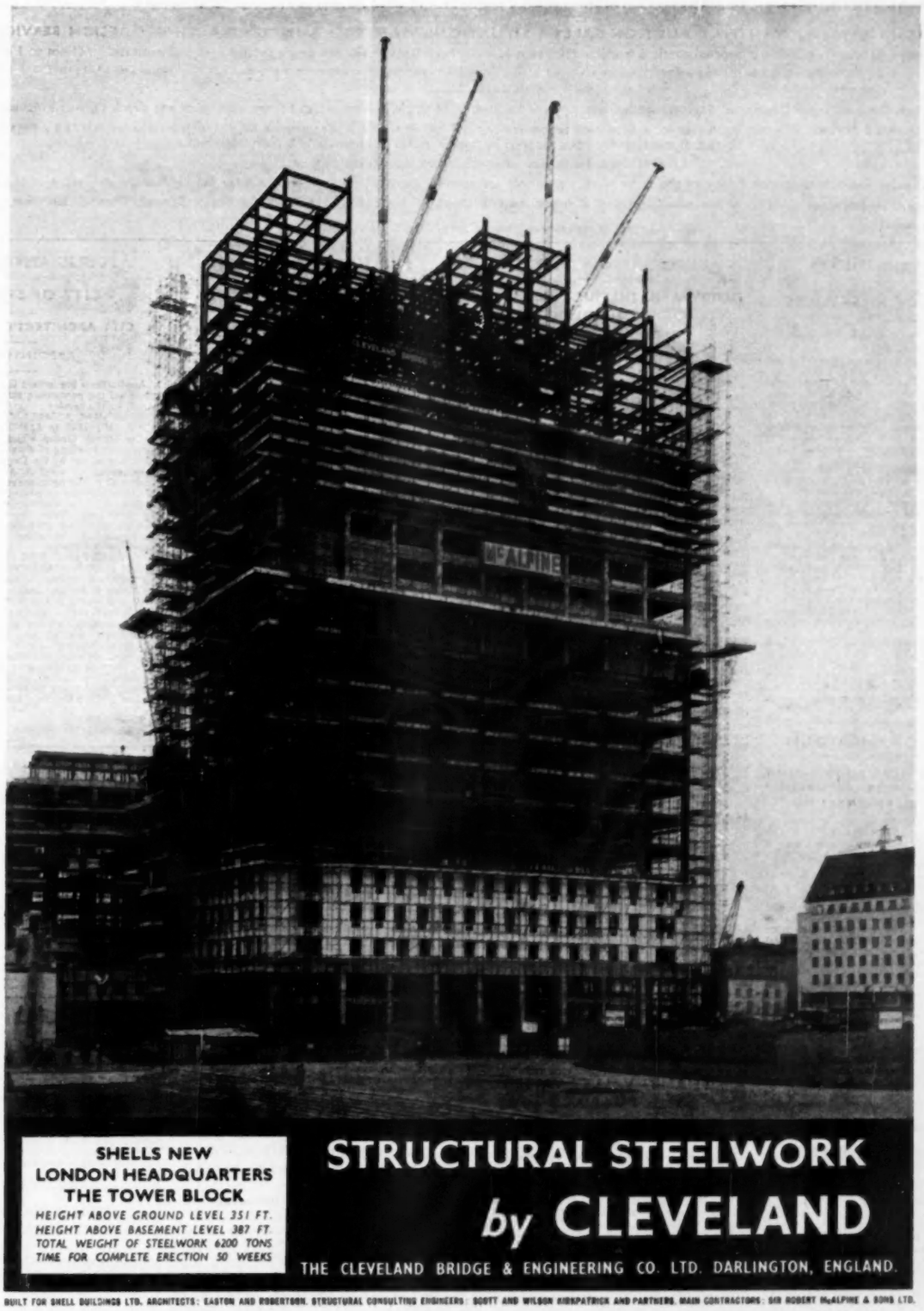
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TOTAL WEIGHT OF STEELWORK 6200 TONS
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There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C. 2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

UNIVERSITY OF KHARTOUM

APPOINTMENTS

Applications are invited for a READERSHIP OR SENIOR LECTURESHIP IN ELECTRICAL ENGINEERING, for a SENIOR LECTURESHIP OR LECTURESHIP IN ENGINEERING MATHEMATICS, and for a SENIOR LECTURESHIP OR LECTURESHIP IN CIVIL ENGINEERING. In the latter post preference will be given to candidates experienced in teaching and research either in Hydraulics or in Surveying and/or Theory of Structures.

Salary Scales:—Reader £S.2175 per annum; Senior Lecturer £S.2052 by £S.75 to £S.2127 p.a.; Lecturer £S.1077 by £S.75 to £S.1977 p.a.

Entry point according to qualifications and experience. Cost of living allowance approximately £S.180 per annum at present. Outfit allowance £S.50. Family allowances: Wife—£S.60 p.a., 1st child—£S.90 p.a., 2nd and 3rd child—£S.30 p.a. each (£S.1—£1 0s. 6d. sterling). Passages are paid for appointee and family on appointment, termination and annual leave. There is a superannuation scheme, and arrangements can be made to maintain F.S.S.U. policies. Appointment on contract for 5 years with possibility of renewal. Unfurnished accommodation provided at rent (excluding rates) up to 7½ per cent of salary.

Applications (10 copies) detailing qualifications and experience and naming 3 referees by 15th November 1960, to Registrar, University of Khartoum, c/o Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1., from whom further particulars can be obtained. E6786

UNIVERSITY OF KHARTOUM

CHAIR OF MECHANICAL ENGINEERING SENIOR LECTURESHIP OR LECTURESHIP IN MECHANICAL ENGINEERING

Applications are invited for the CHAIR OR MECHANICAL ENGINEERING and for a SENIOR LECTURESHIP OR LECTURESHIP IN MECHANICAL ENGINEERING.

Salary Scales:—Professor £S.2760 per annum; Senior Lecturer £S.2052 by £S.75 to £S.2127 p.a.; Lecturer £S.1077 by £S.75 to £S.1977 p.a.

Entry point according to qualifications and experience. Cost of living allowance approximately £S.180 per annum at present. Outfit allowance £S.50. Family allowance: Wife, £S.60 p.a.; 1st child, £S.90 p.a.; 2nd and 3rd child, £S.30 p.a. each (£S1.—£1 0s. 6d. sterling). Passages for appointee and family on appointment, terminations and annual leave. There is a superannuation scheme, and arrangements can be made to maintain F.S.S.U. policies. Appointment on contract for five years with possibility of renewal. Unfurnished accommodation provided at rent (excluding rates) up to 7½ per cent of salary.

Applications (10 copies) detailing qualifications and experience and naming 3 referees by 15th November 1960, to Registrar, University of Khartoum, c/o Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1., from whom further particulars may be obtained. E6785

COLLEGE OF AERONAUTICS

LECTURER IN OPERATIONAL RESEARCH

Applications are invited for the appointment of LECTURER in the new Statistics and Operational Research Unit being formed at this College. In addition to the current teaching programme, it is intended to offer one-year courses in Operational Research for post-graduate students, which are expected to receive considerable international support. Facilities for research are available including the use of a "Pegasus" computer and a well-equipped Operational Research laboratory. Close contact with industry has been established and the unit will investigate and endeavour to provide solutions of real industrial problems. Candidates should be graduates with a minimum of three years industrial experience in Statistics or Operational Research. A knowledge of computers, work study and some consultancy experience would also be an advantage. Salary scale under review; at present £900 by £50 to £1350 by £75 to £1650 p.a. with superannuation under F.S.S.U. and family allowance. Applications, giving full particulars and quoting the names of three referees, to the Recorder The College of Aeronautics, Cranfield, Bletchley, Bucks. Further particulars available. E6782

PUBLIC APPOINTMENTS

DERBY AND DISTRICT COLLEGE OF TECHNOLOGY

Principal: T. HEAP, Ph.D., M.Sc., F.R.I.C., A.M.B.I.M.

DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the following posts, duties to commence in January, 1961, or as soon as possible thereafter:

(a) SENIOR LECTURER IN MECHANICAL ENGINEERING to specialise in teaching Strength of Materials and modern methods of Materials Testing. He will, however, be required to teach other subjects also up to Engineering Degree and Higher National Diploma standard. Applicants should have an honours degree and good industrial and teaching experience.

(b) ASSISTANT (Grade "B" or "A," according to qualifications and experience) to teach the subjects of science and technology to students in Machine Shop Engineering and Foundry and Motor Vehicle courses. Applicants should have good industrial experience and appropriate academic qualifications.

Salary in accordance with 1959 Burnham Scales, viz:

Senior Lecturer: £1550 by £50 to £1750.

Assistant, Grade "B": £700 by £27 10s.—(15) and £37 10s to £1150.

Assistant, Grade "A": £520 by £27 10s.—(16), and £40 to £1000

On the scales for Assistants Grade "A" and Grade "B," allowance is made for degree and approved training and the starting position on the scale is determined by approved industrial experience (up to 12 increments).

Application forms, returnable by the 21st October, and further details can be obtained from the Registrar, Derby and District College of Technology, Kedleston Road, Derby. E6812

HATFIELD TECHNICAL COLLEGE

Principal: Dr. W. A. J. CHAPMAN, M.Sc. (Eng.), M.I.Mech.E., M.I.Prod.E.

DEPARTMENT OF PRODUCTION TECHNOLOGIES

LECTURER

Applications are invited for a LECTURER specialising in Jig and Tool Design and Machine Tools to Higher National Diploma and Higher National Certificate level. Work of Final City and Guilds standard will also be covered.

Applicants should be members of at least one of the professional Institutions and a Degree would be an advantage. Teaching experience is desirable. Salary: £1370 by £35 by £40 to £1550.

Further details and application instructions from Registrar. E6828

THAMES VALLEY WATER BOARD

APPOINTMENTS

Applications are invited from suitably qualified persons for the following appointments:

A. ENGINEERING ASSISTANT: Salary: A.P.T. IV—£1140 to £1310.

B. ENGINEERING ASSISTANT: Salary: Within the range of the special Grade for Engineering and Surveying Assistants: £840 to £1415, and A.P.T. IV £1140 to £1310.

C. JUNIOR ENGINEERING ASSISTANT: Salary: A.P.T. I—£645 to £815.

Applicants for posts A and B should be Chartered Civil Engineers with some years of experience of water supply engineering.

Applicants for post C should have passed the Intermediate, or equivalent, examination of the Institution of Civil Engineers or have completed professional training.

Appointments are subject to the National Scheme of Conditions of Service, the provisions of the Local Government Superannuation Acts, 1937–53, and the passing of a medical examination.

Applications, stating age, qualifications and experience, together with the names and addresses of two referees should be sent to the Engineer and Manager, 16-20, The Forbury, Reading, not later than 29th October, 1960.

O. KEAN, M.I.C.E., M.I.Mech.E., M.I.W.E.
Engineer and Manager.
E6788

PUBLIC APPOINTMENTS

GHANA CIVIL SERVICE

PUBLIC WORKS DEPARTMENT

STRUCTURAL ENGINEER

Applications are invited for the post of STRUCTURAL ENGINEER, Public Works Department.

Duties: Investigation and development of structural designs for new buildings, bridges and other public works and supervision during construction. Qualifications: Candidates must possess (a) either a B.Sc. (Eng.) or other recognised engineering degree with at least 2 years' post-graduate practical experience in structural design work; or (b) being not less than 23 years of age they must have passed the examination of the Institution of Structural Engineers qualifying for election to Associate Membership of the Institution. Salary in range £1080 to £2080 p.a.

Appointment is on contract for two tours each of 15-18 months. Gratuity £150 p.a. Free passages for officer, wife and up to 3 children under 18 years and in addition an education allowance for children when not resident in Ghana and attending full-time school of £100 a child for up to 3 children under 18 years. Accommodation at low rental. Interest free advance for car and car maintenance allowance may be granted. Generous leave on full pay. Income Tax at low local rates.

For application forms, please send postcard to The Director of Recruitment, Ghana High Commission, 248, Tottenham Court Road, London, W.1. E6811

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD AND MID HERTS GROUP HOSPITAL MANAGEMENT COMMITTEE

GROUP SUPERINTENDENT ENGINEER

Applications are invited for the appointment of a GROUP SUPERINTENDENT ENGINEER who will be responsible for the engineering services of all Hospitals in the Group.

Applicants must have completed an apprenticeship in mechanical engineering and have a sound knowledge of the principles and practice of the efficient operation of steam boiler plants and have a wide experience, in a supervisory capacity, of such types of mechanical and electrical services as are found in hospitals. Candidates must have passed an examination in engineering technology and hold First-Class Certificate of Competency in Marine Engineering or an equivalent qualification.

In addition to the normal work of the Group, the successful candidate will be required to associate himself with the installation of the engineering services of the new Welwyn/Hatfield Hospital. The points count for salary purposes will be in the 50½–60 points range.

Salary scale: £1130 to £1325 per annum.

Applications, stating age, experience, qualifications and naming three referees, should be sent to the Group Secretary, Bleak House, Catherine Street, St. Albans, Herts, by 2nd November, 1960. E6798

CHESTERFIELD, BOLSOVER AND CLOWNE WATER BOARD

CHIEF ASSISTANT ENGINEER

Applications invited for the above appointment from suitably qualified persons with considerable experience in Water Supply Engineering. Salary scale J.N.C. Grade B, £1250 - £1485 + 12½% (approximately) in accordance with the recent decision of the Joint Negotiating Committee.

The appointment is next in seniority to the Engineer and Manager of the Board. Housing accommodation will be provided and a car allowance is payable on the essential user scale.

The appointment is subject to the provisions of the Local Government Superannuation Acts, 1937-1953, and will be terminable by one calendar month's notice on either side.

Forms of application and further particulars may be obtained from the Engineer and Manager, New Beetwell Street, Chesterfield, and should be returned to the undersigned not later than Monday, the 31st October, 1960.

RICHARD CLEGG,
Clerk to the Board.
Town Hall, Chesterfield. E6806

PUBLIC APPOINTMENTS

CITY OF SHEFFIELD

CITY ARCHITECT'S DEPARTMENT

APPOINTMENTS

Applications are invited for the following appointments on the permanent staff of the City Architect, Mr. J. L. Womersley:

(a) SENIOR ASSISTANT SURVEYOR—Grade A.P.T. IV (£1140 to £1310). This is a senior post in the Survey Group which is responsible for the survey and levelling of sites for all types of development carried out by the Department, the design and construction of road and sewer works, playing fields and public open spaces and the co-ordination of utility services in connection with new building work both in the outer areas and redevelopment of the inner area of the City.

Applicants must hold a suitable qualification and preference will be given to Chartered Civil or Municipal Engineers.

(b) ASSISTANT SURVEYORS—Grade A.P.T. I (£645 to £815) or M.IV/V (£625 to £760).

Duties will include the survey of land for housing and slum clearance, design of road and sewer layouts, and setting out of works in connection with a considerable capital works programme.

Commencing Salaries within the above Grades according to qualifications and experience.

Applications stating post applied for, age, education and training, qualifications, past and present appointments (with dates and salaries) and the names of two persons to whom reference may be made, should reach the undersigned not later than Thursday, 20th October, 1960.

JOHN HEYS,
Town Clerk.
Town Hall, Sheffield, 1. E6822

ADMIRALTY

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Royal Naval Scientific Service require SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS in establishments in following locations: London Area, Haslemere, Baldock, Poole, Cheltenham, Portland, Portsmouth.

Applications invited from graduates and post-graduate research workers with the following interests:

PHYSICS (classical, mathematical and electronic); ELECTRICAL ENGINEERING (electronic, telecommunications and radio); MATHEMATICS (pure and applied); HYDRODYNAMICS, MECHANICAL ENGINEERING (including servo-mechanisms, gyroscopes and welding development); CHEMISTRY (ceramics with solid state properties).

Candidates must normally be natural born British subjects of natural born British parents, with First or Second Class Honours Degrees or equivalent qualifications. S.S.Os must have had three years' post-graduate experience and be not less than 26 years of age. Salaries (men) S.S.O. £1330 to £1640; S.O. £730 to £1205 (London), somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts. Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street London, S.W.1, quoting Order No. A.359/OA. E5754

CENTRAL ELECTRICITY GENERATING BOARD

RUGELEY (STAFFS) POWER STATION SITE

SITE SAFETY OFFICER

A SITE SAFETY OFFICER is required for the Rugeley (Staffs) Power Station Site of the Central Electricity Generating Board. A thorough knowledge of the Factory Acts and Building Regulations is essential and experience of actual site construction is desirable. Salary in the neighbourhood of £1000 per annum commensurate with experience.

Applications in writing should be sent to:
The Resident Engineer,
Mott, Hay and Anderson,
Rugeley Power Station,
Rugeley,
Staffs,
not later than 24th October, 1960. E6784

PUBLIC APPOINTMENTS

WESTERN NIGERIA DEVELOPMENT CORPORATION

IBADAN, NIGERIA

VACANCY FOR THE POST OF MECHANICAL ENGINEER

The Western Nigeria Development Corporation, Ibadan, Nigeria, invites applications from suitably qualified candidates to fill the vacant post of MECHANICAL ENGINEER in its establishment.

Salary Scale : £1265 by £63 to £1517. Plus inducement allowance of £270 per annum. The point of entry will depend on qualifications and experience.

Qualifications : Candidates should possess one of the following qualifications :

(a) Graduate of the Institute of Mechanical Engineers or an approved equivalent qualification.
(b) A recognised University Degree or Diploma in Mechanical Engineering.
(c) A qualification in Mechanical Engineering obtained at a Recognised University or Institute of Technology in or outside Great Britain.

In addition, candidates' practical experience should include operation of boiler plants, steam and I.C. power units, electrical installation, transport and the control and training of subordinate staff.

Duties : The Officer appointed will be responsible to the Constructional Engineer for the erection of Palm Oil milling plant in a medium-size factory in Nigeria and later for its maintenance and efficient running under the Mill Manager.

Conditions of Service : The terms of service include partly-furnished accommodation at the rate of 8½ per cent. of the basic salary ; free medical service. (In the case of an oversea officer being appointed, an outfit allowance for candidates coming to the tropics for the first time is payable, and a free passage for wife and free passages once each way per tour for children up to 3 in number not over the age of 13 are provided.) Employee is required to contribute 10 per cent. of salary to a Provident Fund ; the Corporation contributes an equal amount. Leave at full pay is granted at the rate of 5 days for every completed month of service. Normal length of tour is 18-24 months.

Method of Applications : Applications should be completed in triplicate on the prescribed form obtainable from the Official Secretary (Recruitment Branch) Office of the Commissioner for Western Nigeria, 178-202, Great Portland Street, London, W.1, for whom further particulars may also be obtained.

Closing date : November 7th, 1960.

E6705

MID AND SOUTH EAST CHESHIRE WATER BOARD

APPOINTMENT OF DEPUTY ENGINEER

Applications are invited for the post of DEPUTY ENGINEER at a salary of £1593 6s. 8d. rising by four annual increments to £1833 6s. 8d. (being two-thirds of the standard salary scale of the Engineer and Manager).

Applicants must be Chartered Civil Engineers, Corporate Members of the Institution of Water Engineers and have had considerable experience in waterworks practice.

A car allowance (essential user) will be paid.

The appointment will be subject to the Local Government Superannuation Acts and to a medical examination.

Full details of appointment and application form, returnable by the 1st November, 1960, may be obtained from Mr. Delwyn G. Davies, B.Sc. (Eng), M.I.C.E., M.I.W.E., Engineer and Manager of the Board, Weaverham Grange, Hartford, Northwich.

C. J. WALKER,
Clerk and Accountant.

E6745

GOVERNMENT OF SIERRA LEONE

ELECTRICITY DEPARTMENT

COMMERCIAL ENGINEER (ELECTRICAL)

Responsible for implementation of tariffs, negotiations and preparation of special agreements, sales control of stores policy, investigation and preparation of cost analysis, &c.

Contract appointment for 3 tours of 18-24 months. Salary range £2300 to £2450 with gratuity. Outfit allowance. Children's allowance. Free passages. Rented quarters.

Candidates 30 to 45 years must be A.M.I.E.E. with experience in budgeting, control of revenue and expenditure and forecasting of expenditure and capital requirements. Write to Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD.145/15/08/D4.

E6755

PUBLIC APPOINTMENTS

NORTH THAMES GAS BOARD

MONCK STREET, WESTMINSTER, S.W.1

SENIOR DRAUGHTSMEN

Applications are invited for the above appointments in North Thames Gas Board at Monck Street, Westminster, S.W.1, for the design and detailing of any of the following :

(a) Reinforced concrete structures and foundations.
(b) Coal and Coke Handling and Screening Plant.
(c) Steel Structures.
(d) Mechanical Plant and pipework associated with gasworks.

The appointments will be permanent and the successful candidates will be required to join the Board's contributory pension scheme.

Salaries will be in accordance with qualifications and experience.

Applications, stating age, qualifications and experience, should be sent to the Staff Controller, North Thames Gas Board, 30 Kensington Church Street, W.8, quoting reference TE/887. E6815

MINISTRY OF AVIATION

ROYAL AIRCRAFT ESTABLISHMENT, BEDFORD

ENGINEER III

Ministry of Aviation requires ENGINEER III at Royal Aircraft Establishment, Bedford, to be responsible for operation, maintenance and development of plant associated with large supersonic wind-tunnel. Qualifications : Engineering apprenticeship and Corporate membership of Institution of Electrical or Mechanical Engineers or equivalent qualifications. Experience in operation of heavy high voltage electrical machinery essential, some knowledge of all common types of air compressor or of power hydraulic servo systems desirable. Salary : £780 (age 25) to £1220 p.a. (provincial). Commencing salary at age 34 or over, £1065. Opportunities for establishment may arise. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D.663/OA. Closing date 26 November, 1960.

E6801

NORTH THAMES GAS BOARD

TAR AND AMMONIA PRODUCTS WORKS, BECKTON, EAST HAM, E.6

DRAUGHTSMAN

DRAUGHTSMAN, aged 21 or over, with O.N.C., required by North Thames Gas Board at the Tar and Ammonia Products Works, Beckton, East Ham, E.6.

The post offers the possibility of obtaining experience in the expanding field of chemical engineering for an applicant who has had a sound mechanical training.

Starting salary will be according to qualifications and experience, and the successful candidate will be required to join a contributory Staff Pension Scheme. Five-day week.

Applications, giving age and full particulars, should be sent to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street, W.8, quoting reference TE/839. E6794

MINISTRY OF AVIATION

HAREFIELD, MIDDLESEX

TECHNICIAN

Ministry of Aviation requires TECHNICIAN at Harefield, Middlesex, in laboratory for creep and stress testing, high temperature tensile testing, heat treatment and calibration of pyrometric equipment. Qualifications : Recognised engineering apprenticeship or equivalent training. O.N.C., City and Guilds Final Certificate or equivalent. Experience in creep testing and control of heat treatment furnaces. General knowledge of metallurgy and mechanical testing. Salary : £975 to £1115. Application forms from Manager (PE.3154), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4.

E6826

PUBLIC APPOINTMENTS

RHODESIA RAILWAYS

VACANCIES FOR SIGNAL AND COMMUNICATIONS TECHNICIANS

Applications are invited to fill vacancies in Rhodesia for SIGNAL AND COMMUNICATIONS TECHNICIANS who are qualified in performing both signalling and telecommunications work, also applicants qualified to perform either mechanical or electrical work.

Single men between 25 and 35 years of age preferred, but married men within this age limit will be accepted provided they are prepared to travel to Rhodesia alone in the first instance.

Salary scale : 62s. 6d. to 68s. per day.

Free passage, pension, good service conditions, including annual leave with pay, sick pay and good prospects of advancement.

Applications in writing should be addressed to :
The London Agent,
Rhodesia Railways,
241, Salisbury House,
London Wall, London, E.C.2. E6809

CIVIL SERVICE

GOVERNMENT SCIENTIFIC ESTABLISHMENTS

RESEARCH FELLOWSHIPS (THREE YEARS)

Value £1275 to £1575 p.a. (Senior) and £875 to £1175 p.a. (Junior). A very wide range of topics, especially in the the PHYSICAL SCIENCES ; also several vacancies in various branches of BIOLOGY. Qualifications : normally first or second class honours degree ; evidence of high standard of ability in research ; and at least 2 years' post-graduate research experience (3 years for Senior Fellowships). No age limits. F.S.S.U. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/5060/60. E6814

EAST RIDING HOSPITAL MANAGEMENT COMMITTEE

SUPERINTENDENT ENGINEER

SUPERINTENDENT ENGINEER required by the East Riding Hospital Management Committee. Successful candidates will be responsible for the maintenance and operation of steam generating plant, electrical mechanical engineering services and heating systems, and should possess an Engineering degree ; A.M.I.Mech.E. or equivalent qualification. Knowledge of minor road repairs and sewage work operation an advantage. Salary : £1070 by £30 (2) by £35 (3) to £1235.

Detailed applications giving two referees to Group Secretary, Westwood Hospital, Beverley, Yorkshire, by 23rd October. E6780

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW

DEPARTMENT OF MECHANICAL, CIVIL AND CHEMICAL ENGINEERING

LECTURER OR ASSISTANT LECTURER IN TRAFFIC AND HIGHWAY ENGINEERING

Applications are invited for the above position in the Civil Engineering section of the Department. Qualifications expected are a good honours degree in Civil Engineering, and for the Lecturer grade research or practical in Traffic Problems. Applications from Mathematicians, or Physicists with interest in this field will also be considered.

Salary scales : Assistant Lecturer £800 by £50 to £950 ; Lecturer £1050 by £50 to £1400 by £75 to £1850.

With family allowance and superannuation.

Further particulars and forms of application may be obtained from the Secretary, The Royal College of Science and Technology, George Street, Glasgow, C.1.

E6774

THE INSTITUTION OF STRUCTURAL ENGINEERS

APPOINTMENT OF

SECRETARY

Applications are invited for the position of Secretary of the Institution of Structural Engineers from men between the ages of 35 and 50. Applicants, who must be British, should possess a University degree, preferably with honours, or be a corporate member of a chartered engineering Institution, or have other suitable professional or service qualifications, and must have wide administrative experience.

Commencing salary will be £3000 per annum ; there is a contributory superannuation scheme.

The successful applicant will be required to take over from the retiring Secretary on the 1st October 1961.

Futher particulars can be had on application to The Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1., the envelope to be marked "Appointment of Secretary".

The closing date for the submission of the detailed applications will be 30th November 1960.

E6764

TENDERS

KINGDOM OF THAILAND

ROYAL IRRIGATION DEPARTMENT, BANGKOK, THAILAND

INVITATION FOR BIDS—NO. YS-3-4

The Royal Irrigation Department of the Kingdom of Thailand hereby invites SEALED WRITTEN BIDS for FURNISHING and DELIVERING the following GOODS, EQUIPMENT, and MATERIALS, either f.o.b. Contractor's shipping point or c.i.f. Bangkok Wharf, Thailand, for the Transmission System, Yanhee Multipurpose Project, Kingdom of Thailand, in accordance with the Contract Documents, for furnishing :

(1) Nine (9) autotransformers, each 20,000 kva, single-phase, Class OA/FA 50 cycle, outdoor, 220/69 kv, complete with L.T.C. and lightning arresters.
(2) Three (3) autotransformers, each 12,000 kva, single-phase, Class OA/FA. 50 cycle, outdoor, 220/69 kv, complete with L.T.C. and lightning arresters.
(3) Three (3) autotransformers, each 10,000/10,000-10,000 kva. single-phase, Class OA/FA. 50 cycle, outdoor, 230/69-13·2 kv, complete with lightning arresters.
(4) One (1) autotransformer, 20,000 kva, three-phase, Class OA/FA, 50 cycle, outdoor, 230/69-12 kv, complete with L.T.C. on tertiary and lightning arresters.
(5) Two (2) 13·2 kv shunt reactors, 5,000 kva each, three-phase, 50 cycle, self-cooled, outdoor type.

Invitation for Bids will be issued in October, 1960, and will be opened in January, 1961. Copies of Contract Documents, Invitation for Bids—No. YS-3-4, 230 KV Autotransformers and 13·2 KV Shunt Reactors, may be obtained by qualified Bidders on written request to : Royal Irrigation Department, Attention : Thai Liaison Engineer, c/o Engineering Consultants, Inc., 1901 South Navajo Street, Denver 23, Colorado, U.S.A.

Each request must be accompanied by a cheque or money order, payable to the Royal Irrigation Department, in the amount of U.S. $25.00 for each copy of the Contract Documents requested. The remittance is non-returnable.

M. L. XUJATI KAMBHU,
Director General
Royal Irrigation Department,
Kingdom of Thailand,
Bangkok, Thailand. E6819

NATO COMMON INFRASTRUCTURE SLICE VI

1. Final notice is hereby given that it is intended to INVITE International Competitive Bids towards the end of 1960 or early in 1961, for the DESIGN, PROVISION and PROVING of a VERY-LOW-FREQUENCY RADIO-TELEGRAPH TRANSMITTING STATION, to be constructed on an already determined site of about 700 acres in the north of England.

2. The station is to be suitable for operation at (a) signalling speeds of approximately 45 bauds when radiating a power of about 100kW at frequencies in the neighbourhood of 20 kc/s : (b) considerably higher signalling speeds when radiating at a somewhat lower power. Amplitude and angle modulation will be required.

3. The approximate value of the work will be £3,500,000 covering all internal and external radio equipment, power distribution and emergency generating plant, buildings, roads on site, &c.

A tendering period of five months will be allowed and completion of the work within three years from the date of contract will be required.

4. It should be noted that the importation of labour from sources outside the United Kingdom may be subject to restriction, and permission could in any case be granted only on an undertaking that the Contractor would pay rates of wages and observe hours and conditions of labour not less favourable than those established for United Kingdom labour for the trades or industries in the same area.

5. Firms wishing to be invited to bid should submit their requests by 14th November, 1960, to :
The Director,
Post Office Contracts Department (A25),
Telephone House,
Temple Avenue,
London, E.C.4.

Within one week thereafter, such firms shall submit evidence of their financial, technical and production resources, and of their ability to provide the V.L.F. station satisfactorily within the time limit stated in paragraph 3 above ; in particular, they should state their experience of large radio-station works. They should also state which major items of this particular work they would intend to sub-contract. As far as is possible, the names, addresses, and resources of the main sub-contractors should also be given.

General Post Office,
London. E6767

THANET WATER BOARD

WHITEHALL PUMPING STATION

REMOVAL AND PURCHASE OF REDUNDANT PLANT

FIXED PRICE TENDERS are invited from experienced Contractors for the REMOVAL and PURCHASE of REDUNDANT PUMPING and STEAM RAISING PLANT from the Board's Whitehall Pumping Station at Ramsgate, comprising Two Lancashire Boilers, One 155 h.p. High-Speed Compound Engine, One 200 h.p Compound Beam Engine, One 50 h.p. Compound Beam Engine, Three Sets of Triple-Throw Bucket Pumps and all associated Pipe Work and Fittings.

Tender documents may be obtained from the Engineer and Manager, Thanet Water Board, 58, Victoria Road, Margate.

Tenders are to be delivered BY REGISTERED POST to The Engineer and Manager not later than 12 noon on 9th November, in the plain sealed envelope provided, and endorsed "Tender for Removal and Purchase of Plant at Whitehall Pumping Station." The envelope must not bear any name or mark to indicate the sender.

The Board does not bind itself to accept the most favourable or any Tender.

T. F. SIDNELL,
Clerk to the Board
40, Grosvenor Place,
Margate, Kent. E6831

Classified Advts. continued on page 128

TENDERS

CITY OF CARDIFF CORPORATION WATERWORKS

LLANDEGFEDD IMPOUNDING RESERVOIR

TENDERS are invited from experienced Contractors for the CONSTRUCTION of LLANDEGFEDD IMPOUNDING RESERVOIR.

Drawings, Specification and Conditions of Tender and Contract may be inspected at the offices of the Engineers, Messrs. Rofe and Raffety, 9, Brewer's Green, Buckingham Gate, Westminster, S.W.1, and at the offices of the Water Engineer and Manager, Greyfriars Road, Cardiff.

Contractors wishing to Tender should make applications for the necessary documents (including prints of the drawings) to the Engineers, accompanied by a deposit of Five Guineas. Cheques should be made payable to the Cardiff Corporation and crossed "Not negotiable & Co.," which will be refunded after the receipt of a bona fide Tender and the return of all documents supplied, or the return o the contract documents by the closing date.

Tenders will not be considered unless enclosed in a plain sealed envelope endorsed only "TENDER FOR LLANDEGFEDD RESERVOIR," addressed to the UNDERSIGNED at the City Hall, Cardiff, and sent by REGISTERED POST so as to be received not later than the 22nd November, 1960.

The envelope must not bear the name of, or any mark indicating the identity of the Tenderer.

The Corporation does not bind itself to accept the lowest or any Tender.

S. TAPPER-JONES,
Town Clerk.

City Hall,
Cardiff. E6821

FYLDE WATER BOARD

WEETON RESERVOIR RECONSTRUCTION

TENDERS are invited from suitable manufacturers for the SUPPLY of a FLOW RECORDER PANEL and HYDRAULIC MEASURING EQUIPMENT.

Further details, specification and forms of Tenders can be obtained from Engineer to the Fylde Water Board, Sefton Street, Blackpool.

Tenders must be returned not later than 17th November, 1960. E6805

TENDER

Tenders are invited for the supply of :—

TRANSFORMERS

Specifications may be obtained on writing to the Purchasing Officer, Trinidad and Tobago Electricity Commission, P.O. Box 121, Port-of-Spain, Trinidad, W.I.

Closing date for Tenders 2nd. December, 1960.

E6815

INDIA SUPPLY MISSION

The Office of the India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8, D.C., United States of America, invites TENDERS for the SUPPLY of the equipment as listed below, required for the manufacture of Streptomycin by Hindustan Antibiotics, Ltd., India.

Indent No.	Tender Enq. No.	Brief description of equipment required	Closing date	Price for Tender
PUR/ISM/ STR/102 ...	SE-249 ...	Steam Control Valves to control the temperature of water in recirculating system at 105 deg. Fah. by regulating the steam-flow to heater	November 8, 1960...	$0·50=3sh. 7d.
PUR/ISM/ STR/101 ...	SE-250 ...	Master enclosed flow Rotor Meters—0-25 Ltr./Min. and 0-50 Ltr./Min.	November 8, 1960...	$0·50=3sh. 7d.
PUR/ISM/ STR/100 ...	SE-251 ...	Pressure Indicators with with Chemical type diaphragm gauges, various ranges	November 8, 1960...	$0·50=3sh. 7d.

Specifications &c., relative to the above specifications can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, London, W.3. The cost of Tender sets are as indicated above and are not refundable.

Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8, D.C., United States of America, *and not to this Office*, and are to reach them on the dates specified above against each enquiry number.

Specimen copies of the above enquiries can be seen at Engineering Branch, India Store Department, Government Buildings, Bromyard Avenue, Acton, London, W.3, under the above Tender reference numbers. E6772

EDUCATIONAL

A.M.I.MECH.E., B.SC., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus, free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

LANCHESTER COLLEGE OF TECHNOLOGY, COVENTRY

DEPARTMENT OF APPLIED PHYSICS

Evening Course on
NUCLEAR ENGINEERING

A series of 14 weekly Wednesday evening lectures for Physicists and Engineers on NUCLEAR ENGINEERING will begin on November 2nd, 1960, at 6.30 p.m.

Fee : £1 12s.

Full particulars and forms of application from the Head of the Department of Applied Physics.

E5997 E

UNIVERSITY OF SHEFFIELD

FAILURES IN MACHINES AND STRUCTURES

A COURSE OF ELEVEN LECTURES, with discussion, on failures in a wide range of branches of mechanical engineering, Tuesday to Friday, 25th to 28th October.

Apply to Professor W. A. Tuplin, Applied Mechanics, University, St. George's Square, Sheffield 1 E6773 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A SECTION HEAD with a background of technical writing and engineering is required to lead an expanding technical translation group in a Research Organisation. Applicants with languages will be given special consideration. The appointed man would be expected to control all aspects of the work and development of the group. Excellent working conditions in pleasant surroundings. Pension scheme. Send further details of experience and present salary quoting I.740 to BOX No. E6094, "The Engineer." A

A SENIOR DRAUGHTSMAN

experienced in plant layout and services who requires

work of unusual variety and scope in a secure branch of industry is invited to join the Drawing Office of H. J. Heinz Company Limited at their Head Office in North West London.

The Company occupies a leading place in the expanding food industry and the appointment offers a position which is permanent and progressive with employee benefits including a non-contributory pension scheme. The successful candidate's duties will be concerned with plant layout, vessel design and general factory services, and a commencing salary up to £18 per week is proposed.

Please apply with full details of past employment and education to the Personnel Officer, H. J. Heinz Company Limited, Waxlow Road, Harlesden, London, N.W.10.

E6832 A

CONVEYOR DESIGN

SENIOR DESIGN DRAUGHTSMAN with extensive experience in all types of Conveyor required for a new factory near Bombay. Three years contract with passages paid for family and free furnished accommodation. Salary up to £2500 per annum depending on experience.
Apply BOX No. E6796, "The Engineer."

A

SITUATIONS VACANT

BORG-WARNER LIMITED

Manufacturers of Automatic Transmissions and Overdrives invite applications from :

TRANSMISSION LAYOUT MEN required for interesting work on new products in the field of automotive transmissions. Candidates will be expected to have had a recognised mechanical engineering apprenticeship and be educated to H.N.C. standard (mechanical). Experience in epicyclic gear train design and hydraulic mechanisms would be desirable. Opportunity to work on own initiative with minimum of supervision. Excellent conditions and prospects are offered in a Company which has embarked on a considerable expansion programme.—Please send applications, giving full details of qualifications, experience and present salary, to Personnel Manager, Borg-Warner Limited, Letchworth, Herts.

E6790 A

DRAUGHTSMAN required with or desiring experience in railway carriage and wagons or diesel traction. Man with good general or structural engineering experience considered. Superannuation scheme in operation. Salary commensurate with qualifications and experience.—Apply The Secretary, The Birmingham Railway Carriage & Wagon Co. Ltd., Smethwick, 40, Staffs. E6803 A

ENGINEERING INSURANCE. Applications are invited from Engineers, not over 35 years of age, who have served an apprenticeship and have a sound theoretical and practical knowledge of cranes and lifting machines and are technically qualified to Higher National Certificate standard, for a vacancy in the Taunton area. The position is permanent, pensionable, with salary scale £800 rising to £1100 per annum, plus other expenses and allowances.—Apply in own handwriting to BOX No. E6793, "The Engineer." A

ENGINEERING INSURANCE COMPANY invites applications from Engineers not over 35 years of age who possess First Class M.O.T. Certificate (Steam) for position as MECHANICAL ENGINEER SURVEYOR in Bristol and surrounding areas. Progressive salary scale commencing at £800 rising to £1100 per annum, plus other expenses and allowances. Non-contributory pension scheme.—Apply, in own handwriting, to The Northern Assurance Company Limited, 1, Moorgate, E.C.2. E6794 A

ENGINEER wanted to assist Works Manager and to be responsible to Directors for Company's finished products. Knowledge of Press Tools and Welding Fixtures essential.—Modern Conveyors Limited, Aynho Road, Adderbury East, Near Banbury, Oxon. Tel.: Adderbury 238/9. E3031 A

ESTIMATING ASSISTANT for London Office of large North country Engineering concern. Applicants should hold O.N.C. or preferably H.N.C., and be 22 or over.—Full details of past experience and present employers should be stated in strict confidence to BOX No. E6777, "The Engineer." A

F. R. BULLEN & PARTNERS, Consulting Engineers, require for their Glasgow and Darlington offices detailers experienced in reinforced concrete or structural steelwork.—Applications in writing should be sent in the first instance to Dacre House, Dean Farrar Street, Westminster, London, S.W.1. E6727 A

FORENSIC ENGINEERS invite applications from Engineering Graduates and/or Corporate Members of a senior Institution with good background and industrial experience for responsible and individualistic posts. Age not over 35. Posts available in Cardiff and Manchester.—BOX No. E6770, "The Engineer." A

JACKSON INDUSTRIES LIMITED

Dallow Road, LUTON,
require

SENIOR DRAUGHTSMAN FOR WORK ON ELECTRICAL DOMESTIC APPLIANCES

Experience of these products would be an advantage and knowledge of sheet metal fabrications would be useful.

ALSO

SENIOR JIG AND TOOL DESIGNER required

for work on press tools and mass production pipework jigs.

E3032 A

MANAGER

required for the Engineering Works of Mitchell Cotts & Co. (Libya) Ltd., in Tripoli, engaged in steel fabrication, machining, fitting and assembly, with 160 employees. Age over 30 years, commencing salary up to £2800 p.a. (amending the figure in our earlier advertisement), with furnished accommodation and non-contributory pension scheme. Regular home leave on full pay. Previous overseas experience and ability to speak some Italian advantageous. This post offers an interesting opportunity in an expanding business to an engineer with the necessary experience and initiative.

Applications to :
Personnel Officer,
Mitchell Cotts Group Ltd.,
Cotts House, Camomile Street, London, E.C.3.

E6818 A

MAINTENANCE ENGINEER

A large manufacturing company has a vacancy for a Mechanical or Electrical Engineer to be engaged on the installation and maintenance of plant and machinery at its North Kent works. Applications are invited from qualified engineers between 28 and 40 years of age with industrial experience. The initial salary will be in the region of £1,100. Apply giving details of career and present salary to The Chief Personnel Manager, BOX No. E6771, "The Engineer." A

SITUATIONS VACANT

GENERAL WORKS MANAGER

required for old-established light Engineering Company situated in Bradford.

This is a new appointment brought about by expansion of business and the consequent need to reorganise. The successful candidate will be required to take full control of production and production personnel, and to advise the Board on problems relating thereto.

Growing business with good prospects. Management experience essential. Age 35 to 45 preferred.

Please send full details and salary required in confidence to Adgie Roberts & Co., Chartered Accountants, 26, Park Row, Leeds, 1.

E6789 A

MANAGER for medium-sized Engineering Works in S.E. London. The post will entail responsibility for Production, Design and Drawing Office and Works Administration. The person appointed should be 30-35 years old and have sound technical and practical knowledge of M.S. Fabrications, Machining, Fitting and Assembly Work. Experience of Hydraulic Press construction and/or Stainless Steel and Aluminium fabrications would be an added qualification.—Write, giving full details of experience, qualifications and salary to BOX No. E3028, "The Engineer." A

PERSONAL ASSISTANT TO WORKS DIRECTOR of a Group of Engineering Companies in England and the Continent required to investigate and co-ordinate developments in Production Control, Design and manufacture of new and existing products. Excellent opportunity for young well-qualified Mechanical Engineer, aged 26-35, to obtain Managerial experience with a view to promotion. Knowledge of Mechanised Foundries and French an advantage.—Full particulars of training, experience to date and present salary to BOX No. E6823, "The Engineer." A

PLANNING AND PROGRESS ENGINEER

required by the United Kingdom Atomic Energy Authority, Production Group, Springfields Works, Salwick, Preston, Lancashire, to be responsible to the Senior Planning Engineer for planning and progress of plant overhauls and operation of a comprehensive Planned Maintenance Scheme. Work involves co-ordination of all sections of Works Engineering Department.

A recognised engineering apprenticeship, corporate membership of a senior engineering institution, or equivalent, and experience in planning and progressing of maintenance projects as applied to a large Works, are essential. Familiarity with operation of Planned Preventative Maintenance Schemes is desirable.

Salary : £1370 to £1825 per annum.

Staff Housing Schemes. Contributory Superannuation.

Send postcard for application form, quoting reference SF.74/J1, to Works Secretary at above address.

Closing date : 31st October, 1960. E6800 A

PROJECT ENGINEER required at once for Development Section of manufacturer of cranes and handling equipment. Good mechanical design qualifications are essential, and an ability for original thinking. The post is permanent and pensionable, situated in Manchester.—BOX No. E6820, "The Engineer." A

SENIOR DRAUGHTSMAN with sound experience of steel and timber formwork design, required by major civil engineering and building contractors at their head office. Good salary, commensurate with experience and ability. Entry into Superannuation Scheme after 12 months' satisfactory service.—Apply, stating age and experience, to : The Mitchell Construction Company Ltd., Wharf Works, Peterborough. E3205 A

SHELL-MEX AND B.P. LTD.,
INVITE APPLICATIONS for the
POSITION of an
ENGINEER

in their Western Divisional Office, Bristol. Candidates should be between 25 and 35 years of age and have a thorough works training, possessing Corporate Membership of either the Institute of Civil or Mechanical Engineers, or have passed Parts "A" and "B" of one of these Institutes, or hold qualifications entitling them to exemption from such examinations. Salary according to qualifications, experience, &c. First-class Pension Scheme.—Applications should be addressed to Staff Supervisor, Shell-BP House, Wine Street, Bristol, 1.

E6776 A

SHIFT ENGINEERS required for Sugar Factory on medium sized Sugar Estate in Trinidad. Candidates should be aged 21-25, single holders of O.N.C. Good salary and free furnished quarters and medical care. This vacancy would suit an Engineer who has recently completed his apprenticeship.—BOX No. E6829, "The Engineer." A

TECHNICAL AUTHOR required not over 50, to undertake the compilation of operating and maintenance instruction manuals dealing with the Company's machinery. This interesting and progressive pensionable staff position would appeal to a suitably qualified Mechanical Engineer with a bias towards technical writing.—Applications should be addressed to the Personnel Manager, Molins Machine Company Ltd., Evelyn Street, London, S.E.8.

E6733 A

TECHNICAL SALES ENGINEER required for position in London by Chemical Engineering Company. The qualifications required are age about 25, engineering training up to B.Sc. standard or equivalent and good knowledge of physics. Some knowledge of chemistry and some experience in Chemical Engineering desirable but not essential. An understanding of general office procedure would be advantageous. This situation offers scope for travel and the handling of business in a varied field; also excellent opportunities for a man having these qualifications together with a keen business outlook.—Write, giving full particulars, including age, qualifications and salary required to BOX No. E6751, "The Engineer." A

SITUATIONS VACANT

TECHNICAL REPRESENTATIVE required by pump manufacturers, age 28-36, based Lancashire. Some design experience an advantage but not essential. Preference given to gentleman with connection in chemical industry. Salary range £1100 to £1300, plus incentive bonus, car and expenses.—BOX No. E3024, "The Engineer." A

THE GLACIER METAL COMPANY LIMITED

Invites applications from

QUALIFIED ENGINEERS

for two posts in their Headquarters Engineering Organisation, both responsible to the Engineering Standards Manager.

THE MACHINE SPECIFICATION ENGINEER has two main responsibilities :

i To make arrangements for building process plant and special purpose machine tools developed by the Company for its world-wide network of licensees.

ii To develop comprehensive intelligence information about all relevant British and European machine tools covering cost, specification, availability and critical appraisal of their individual merits and performance involving direct visits to suppliers.

THE ENGINEERING STANDARDS OFFICER manages a small team, preparing and issuing Company technical standards. He must maintain and develop a central source of information about these Company-wide standards covering products, materials, packing and presentation and also ensure that the Factories receive complete and up-to-date drawings and specifications for their production orders.

Both these posts present opportunities for experience in a wide range of engineering work in a Company where career prospects are excellent. Qualifications at H.N.C. or degree level are preferred, though especially relevant experience may be accepted as an alternative.

Salary range : £950 to £1350 per annum.

Applications should be sent to
Personnel Divisional Manager,
(Ref : HQE),
The Glacier Metal Company Limited,
Ealing Road, Alperton, Wembley, Middlesex.

E6799 A

THE REED PAPER GROUP have a vacancy for an experienced Instrument Engineer in their Instrument Department at Aylesford Paper Mills, Nr. Maidstone, Kent. Candidates should have wide experience in installation and maintenance of pneumatic and hydraulic process control equipment. Good salary and prospects, non-contributory pension scheme etc. Apply with full particulars of age and experience to Personnel Manager, Aylesford Paper Mills, Larkfield, Nr. Maidstone, Kent

E6781 A

THE SUDAN GEZIRA BOARD, Barakat, Blue Nile Province, Republic of the Sudan, invite applications for the post of DEPUTY CHIEF MECHANICAL ENGINEER. Salary range : £1400 to £1800 three year contract with one-fifth total basic salary gratuity at the end of the contract. Successful candidate and family entitled to free house, free passage (air or sea) to and from the Sudan each year.—For further details, please write to Sudan Gezira Board Representative (U.K.), Castle Chambers, Castle Street, Liverpool, 2. E6817 A

TOP COPYWRITERS AND POTENTIAL COPYWRITERS—study the advertisements of leading diesel manufacturers in the technical Press. If you think you can write advertising copy equal to the best of these, perhaps even better, and if you would like to work with us in the pleasant City of Lincoln, then we shall be glad to hear from you. Applications treated in absolute confidence. State present salary, age, and qualifications.—Please write to BOX No. E6813, "The Engineer." A

YOUNG ENGINEER required, minimum qualifications H.N.C. in mechanical engineering and some drawing office experience, to develop and control new production where engineering training is of major importance. This job offers interest, opportunity, and excellent future prospects to an ambitious, conscientious and intelligent young engineer.—Apply to BOX No. E6795, "The Engineer." A

ASSISTANT WORKS ENGINEER

required

Candidates must have served a practical apprenticeship in a medium engineering industry, with subsequent drawing office training. Essential qualifications are as follows :

(*a*) Experience in Machine Tools, Steam, Electrical and Heating Plant installation and maintenance, also factory and office lay-out.
(*b*) Ability to control staff.
(*c*) Technical qualifications to H.N.C. Standard, or equivalent.

Applicants should be keen, energetic, and adaptable, and preferably aged 35-45 years. Those who replied to a similar advertisement recently need not re-apply, as their applications will be re-considered.

Contributory Staff Pension and Life Assurance Scheme.

Applications, giving full details of qualifications, experience, age and salary required and quoting Ref. H.A.L./141/ENG should be addressed to :

The Personnel Manager,
HUNTING AIRCRAFT LIMITED,
Luton Airport,
Beds.

E6824 A

CJB

CONSTRUCTORS
JOHN BROWN LIMITED

require a

SENIOR
STANDARDS ENGINEER

Corporate Membership of a professional institution and/or possession of an Honours Degree would be preferred. Considerable design experience in process engineering over the past 10 years, plus at least two years in the Standards Department of a large Organisation essential.

Duties will include responsibility for the setting up and running of a Standards Organisation. Membership of a body or committee (e.g. B.S. Committee) would be an asset.

Please write, giving full details and quoting reference number K7918 to :

The Personnel Manager,
CONSTRUCTORS JOHN BROWN LTD.,
C.J.B. House, Eastbourne Terrace,
Paddington, London, W.2.

E6779 A

BRITISH TRANSPORT DOCKS

invite applications for vacancies at Garston Docks, Nr. Liverpool:—

ENGINEERING ASSISTANT (CIVIL). Experience in design and construction of major new works, maintenance (including permanent way), and staff administration. Corporate Membership of the Institution of Civil Engineers. House available. Commencing salary £1,205 per annum.

NEW WORKS ASSISTANT. Experience in design, execution and maintenance of civil engineering works, knowledge of specifications and quantities. Associate Membership of the Institution of Civil Engineers desirable. Commencing salary £1,150 per annum.

Contributory superannuation scheme and certain rail travel facilities.

Applications giving age, experience, qualifications and present position to be forwarded to Staff & Establishment Officer, British Transport Docks (Dept. E), Melbury House, Melbury Terrace, London, N.W.1., to arrive not later than 20th. October, 1960.

E6797 A

PRODUCTION ENGINEERS

Young men of experience and ability are invited to join enthusiastic teams carrying through a re-organisation and expansion in our factories.

THE GROUP Fleming and British American Optical Industries Limited. Two factories are in Watford, one in S. Wales, one in London and small manufacturing units in most major cities. One production engineer will be appointed to each factory. Our production methods vary from mass to precise "one off" techniques with millions of pieces processed and handled each year.

THE JOB To join a Factory Manager's team at a senior level and make *significant* contributions by a systematic review of the methods, layouts, machines and machine utilisation, materials handling and usages, planning, pre-production preparation and production costs ; to determine the best methods to increase production at Lower unit cost with increased quality and flexibility of output.

THE PROSPECTS Knowing the market value of these jobs we are prepared to pay above average salaries for the men we want. Future salary movement and promotion avenues are excellent.

THE MEN Aged 35 and under, well qualified academically and by experience to carry out the above assignments—almost certainly through working for modern manufacturing companies.

Initial applications to :

Group Personnel Manager
FLEMING & BRITISH AMERICAN OPTICAL INDUSTRIES LIMITED
Rochdale House,
128 Theobalds Road, London, W.C.1.

E6765 A

BOOKS and PUBLICATIONS

Tabular Summary of Civil Engineering Contracts

BRITISH SCHEMES AT HOME AND ABROAD

This Summary is published annually in December as a Supplement to the final issue of THE ENGINEER for the year.

It consists of tables giving brief particulars of important civil engineering schemes on which work was proceeding during the 12 months prior to publication. It also includes schemes completed during the year and new schemes for which contracts were awarded. In general, contracts below £50,000 in value are not included, unless they form part of a larger scheme.

The Summary is divided into sections dealing with Airports, Coast Protection, Drainage & Sewage Works, Harbours & Docks, Hydro-Electric Works, Irrigation, Power Stations, Railways, Rivers & Waterways, Roads, Steelworks, Structural & Industrial and Water Supply—in all approximately 80 pages of text.

Every subscriber to THE ENGINEER receives one free copy of the Summary and additional copies are sold at 1/6d each plus postage.

Full Page Advertisements (10" × 7") are offered facing text in all sections, subject to the space being available when orders are received. COPY DATE OCTOBER 30th.

From the advertisers' point of view the Summary offers an excellent opportunity of appearing facing text in a publication which is highly valued by those concerned with a wide variety of civil engineering schemes both at home and abroad.

For details of advertising or regarding the supply of copies please write to :

The Manager,
THE ENGINEER,
28, Essex Street,
Strand,
London W.C.2.

Enter No. 1291 on reply card

IMPERIAL SMELTING

A MEMBER OF THE CONSOLIDATED ZINC CORPORATION LIMITED

The following Staff vacancies are currently available.

MATERIALS ENGINEER

This is a new post with Consolidated Zinc Corporation (Sales), Ltd., for a man over the age of 25 possessing a good personality and with professional, engineering or metallurgical qualifications and conversant with the problems of nuclear power generation. Honours degree is preferred but the main requirement is a thorough knowledge of the engineering applications of materials and the ability to promote sales of beryllium and its alloys. A knowledge of the engineering requirements in the aeroplane structure, guided missile and guided system fields would be an advantage.

TE/ME

ASSISTANT CONSTRUCTION ENGINEER

An engineer with H.N.C. or preferably with professional qualifications in Civil or Structural Engineering and at least three years' previous appropriate supervisory experience, will be required to assist in the supervision of all construction work at the Avonmouth Works.

TE/ACE

ASSISTANT INSTRUMENT ENGINEER

A qualified engineer, preferably with professional qualifications, or University Degree in Physics, Electrical Engineering and Electronics, but a candidate with H.N.C. or similar qualification will be considered. Knowledge and experience of instrument maintenance and development in the heavy chemical or metallurgical industry is essential.

EG/AIE

DRAUGHTSMEN

Mechanical and Civil Draughtsmen required for design and detail work in our drawing offices. The work is varied and deals with metallurgical and chemical plant and equipment. At least two years' previous Drawing Office experience is essential and applicants should either possess or be prepared to obtain a National Certificate.

TE/DM

Applications for the above vacancies, quoting the reference of interest, and giving brief details of qualifications and experience, should be addressed to :—

Personnel Manager,
Imperial Smelting Corporation Ltd.,
St. Andrew's Road,
Avonmouth.

E6714 A

Classified Advts. continued on page 130

SITUATIONS VACANT

DRAUGHTSMEN

We have a requirement for a large number of Designers and Draughtsmen at all levels experienced in :

ELECTRONIC AND COMPUTER EQUIPMENT
AIRFRAME STRUCTURES
HYDRAULIC SYSTEMS
RADIO OR SCIENTIFIC INSTRUMENTATION
STRUCTURAL, MECHANICAL & ELECTROMECHANICAL DEVICES

HOUSING ASSISTANCE MAY BE POSSIBLE

Applications to be sent to:— Technical Personnel Officer, c/o Dept. G.P.S. English Electric House, Strand, London, W.C.2. quoting reference E1399U.

ENGLISH ELECTRIC AVIATION LTD
Guided Weapons Division
London — Luton — Stevenage

E5914 A

SITUATIONS VACANT

OPPORTUNITY FOR YOUNG REFRIGERATION ENGINEER

An excellent opportunity exists for a young British engineer, with at least three years' experience in industrial refrigeration. Applicants must possess a B.Sc. in Mechanical Engineering or an equivalent qualification ; specialised knowledge of heat transfer or refrigerating compression plant will be advantageous.

Duties under guidance at commencement will include design, preparation of tenders and contract work with an increasing share of responsibility. Excellent prospects. All applications treated in strictest confidence.

Apply for an interview, stating age, qualifications and experience, to :

The Personnel Manager,
John Thompson (Wolverhampton) Ltd.,
Ettingshall,
Wolverhampton.

E6787 A

SITUATIONS VACANT

ASSISTANT WORKS MANAGER

required for Engineering Company in East End of Glasgow.

The Company employ over 600 and applicants should have experience in heavy mechanical and structural engineering. Knowledge of modern welding practice will be an advantage.

Attractive conditions, including Salary, Holidays and Pension are offered, and the post is one which will definitely give prospects of advancement to a suitable applicant.

Full particulars of experience and age should be stated.
BOX No. E6802, " The Engineer " A

SITUATIONS VACANT

QUALIFIED ENGINEER

aged 25-30, required to assist Factory Manager on technical matters associated with production, and to help implement existing plans for the expansion of this Factory.

Qualifications desired include H.N.C. and experience in production engineering.

Salary according to age and experience ; Staff Life Assurance and Pension Scheme.

Please write for application form, giving age and brief details of qualifications and experience to :

Personnel Manager,
Universal Grinding Wheel Co., Ltd.,
Stafford

E6792 A

W. H. ALLEN SONS & COMPANY LTD. BEDFORD

require

AN ASSISTANT ELECTRICAL DESIGNER

(Ref. 506/5)

Applications are invited for the post of an Assistant Electrical Designer to work on small to medium size A.C. machines.

The successful candidate will be between 21-30 years old and have either

(*a*) An H.N.C. in Electrical Engineering and previous experience in this type of work, or
(*b*) A degree in Electrical Engineering but whose experience in this field is limited.

In either case appropriate Membership of the Institution of Electrical Engineers is desirable.

EXPERIENCED MECHANICAL DRAUGHTSMEN

(Ref. 404/5)

Applications are invited from experienced Mechanical Draughtsmen for positions in the Turbine and the Diesel Departments.

Previous experience in these particular fields is not essential provided general mechanical experience has been obtained.

The Company offers excellent prospects to the right men, good conditions of service and operates a contributory Pension and Life Assurance Scheme. Where appropriate, assistance will be given towards the expense involved in settling in the Bedford area.

Application forms can be obtained by writing (quoting the appropriate reference) to :
THE PERSONNEL MANAGER, QUEENS ENGINEERING WORKS, BEDFORD

E6091 A

ASSISTANT WORKS STUDY OFFICER

LOCATION : The post is based at Coventry, covering the greater part of Warwickshire.

REQUIREMENTS : A sound engineering background, experience in work measurement and method investigation and awareness of the latest techniques.

SALARY : Not less than £1,300 per annum. Generous Pension, Sickness and Holiday Schemes.

PLEASE WRITE FULLY TO : **Industrial Relations Officer, WEST MIDLANDS GAS BOARD, 6 Augustus Road, Edgbaston, Birmingham, 15.**

E6827 A

Shell-Mex and B.P. Ltd. have vacancies in the United Kingdom for an ENGINEER and a DRAUGHTSMAN

The Engineer is required for the expanding Pipeline Department. His duties will include construction work and maintenance on an existing underground pipeline network.

Candidates should possess either Corporate Membership of the Institutions of Civil or Mechanical Engineers or have passed parts A and B of one of these Institutions' examinations or have qualifications entitling them to exemption from such examinations. A working knowledge of cathodic protection will be an advantage. Preference will be given to those under 35.

The Draughtsman should be able to work with the minimum supervision and will be responsible for visiting Installations and checking on site. Later on he will be required to produce working drawings for appending to contracts.

Conditions of employment in the company are excellent, and there is a particularly good pension scheme. Starting salary will depend on qualifications and experience. Replies should be sent to the address below quoting reference No. CA/120 in the case of the Engineer and reference No. CA/121 in the case of the Draughtsman.

The Staff Manager, Shell-Mex and B.P. Ltd.,
Shell-Mex House, Strand, London, W.C.2.

E6833 A

ENGINEERS

A new Division manufacturing industrial rubber products was formed recently by an old-established Company in the North. Continued expansion necessitates the recruitment of the following staff.

CHIEF DRAUGHTSMAN (age over 35)

A well qualified designer is required to direct two small D.O. sections, each with a Senior Designer, and to be responsible to the Chief Engineer.

Applicants must have a good record of responsible design work in the rubber and plastics industry or in a similar field, and experience of standard rubber plant and factory services. Ingenuity combined with sound general engineering knowledge is required for the design of special purpose machinery. H.N.C. in Mech. Eng. is a minimum standard.

The successful applicant will have an opportunity to apply his own ideas in building up a design unit. To attract the man who is already well-paid, a substantial salary is offered.

SENIOR DESIGNER (age about 30)

A design draughtsman will be appointed as leader of a small D.O. section, at present being formed. Knowledge of rubber plant would be helpful but experience in general engineering is more important.

Preferably, the successful applicant will have gained H.N.C. and although basically a mechanical engineer, have experience of all services.

ASSISTANT PROJECT ENGINEER (age 25 to 30)

An Engineer is required to assist in projects from initial investigation through design and pilot manufacture stages to the setting up of a new production unit.

Applicants should have H.N.C. (Mech. Eng.), five years' practical training and at least three years' D.O. experience in general engineering. Previous experience of plant lay-out including services, particularly in the Rubber Industry, will be a considerable advantage.

ASSISTANT WORKS ENGINEER (age over 25)

H.N.C. (Mech. Eng.) would be an advantage but it is more important that the successful applicant has a sound general engineering background and the initiative to get things done, using the services of an Engineering Maintenance and Service Department. Knowledge of rubber plant would be useful.

These are progressive and permanent positions offering attractive salaries, with an annual review and bonus. Superannuation, housing and removal assistance is available.

Interviews can be held at week-ends and outside office hours, if necessary in the area where applicants live. All applications will be acknowledged and treated in strict confidence. They should be addressed to Chief Engineer, BOX No. E6804, " The Engineer."

A

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E195 A

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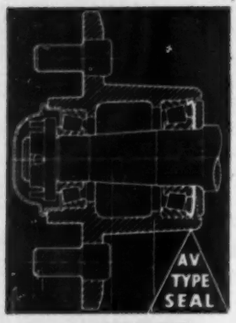

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October 25	Machine tools and miscellaneous stores. including :—	W.D. Storage Depot, Byley, Nr. Middlewich, Cheshire. (Sale at Cheetham Town Hall, Manchester 8).	J. H. NORRIS & SON, (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373)
	Lathes ; millers ; grinders ; power hammer ; band and circular saws ; drills ; industrial auto-trucks ; fork lift truck ; 2-ton trailers ; M.T. and aircraft spares ; gen. sets ; iron bedsteads ; furniture ; weighing machines ; power mowers ; scrap tyres and batteries ; canteen equipment ; textiles various.		
October 28	Miscellaneous stores.	Returned Stores Group, Reed Hall, Colchester, Essex.	FENN WRIGHT & CO., (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 73171)
November 1	Miscellaneous stores.	W.D. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON, (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham, (Tel.: 54272)
November 8-9	Machine tools and miscellaneous stores.	W.D. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18.	FULLER, HORSEY, SONS & CASSELL, (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861)
November 15-16	Vehicles and miscellaneous stores.	Central Ordnance Depot, Bicester, Oxon.	MIDLAND MARTS, LTD., (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73)
November 24	Vehicles and miscellaneous stores.	W.D. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.	DIXON & WALLACE LTD., (Dept. L), Bank Buildings, Graham Square, Glasgow, E.1. (Tel.: Bridgeton 2447/9)
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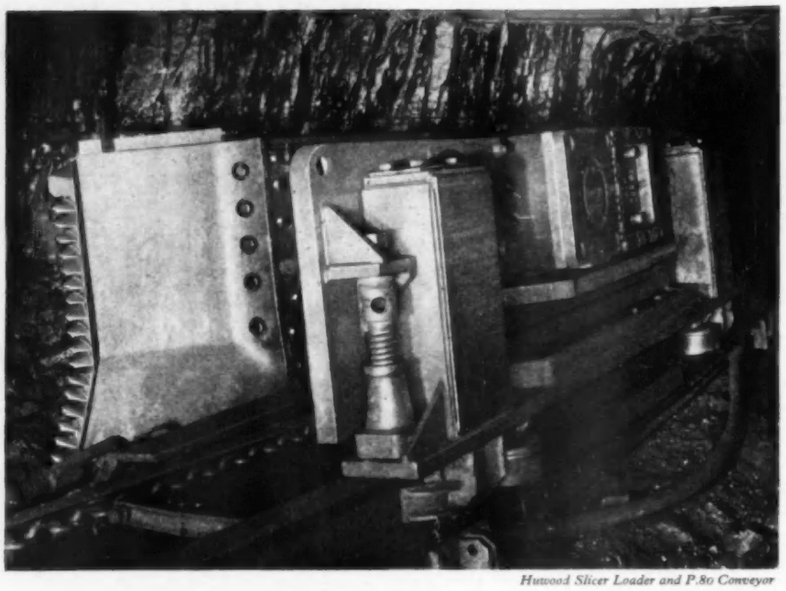

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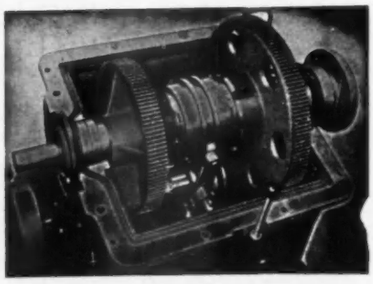

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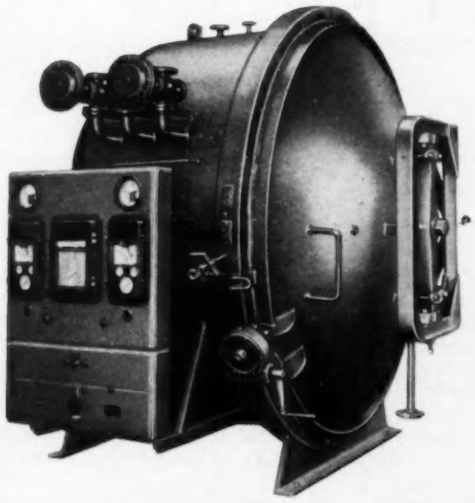

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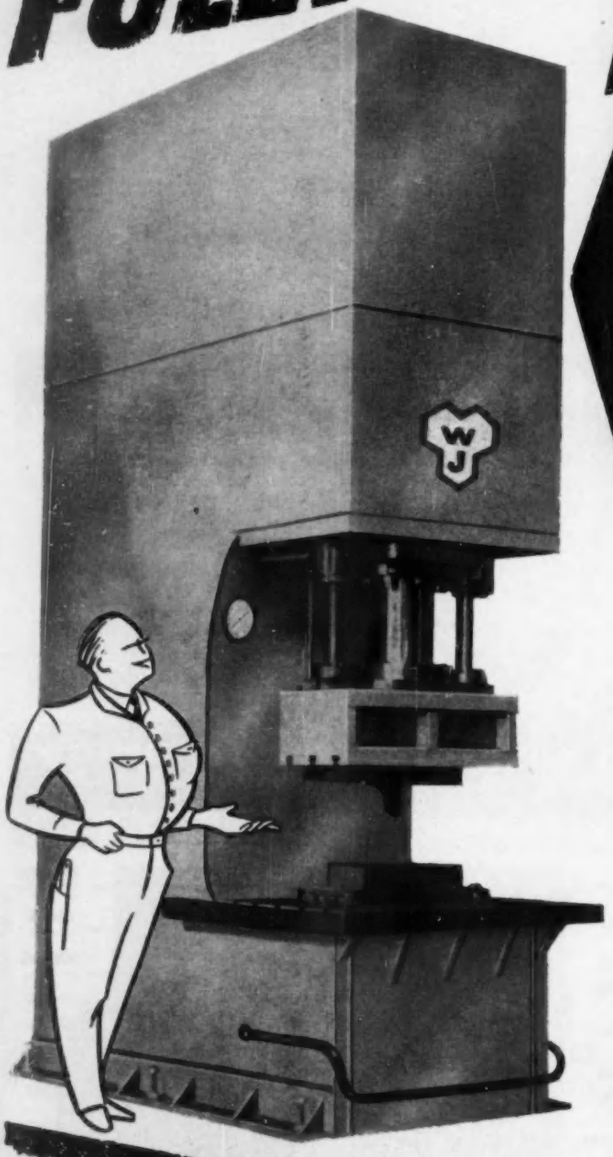

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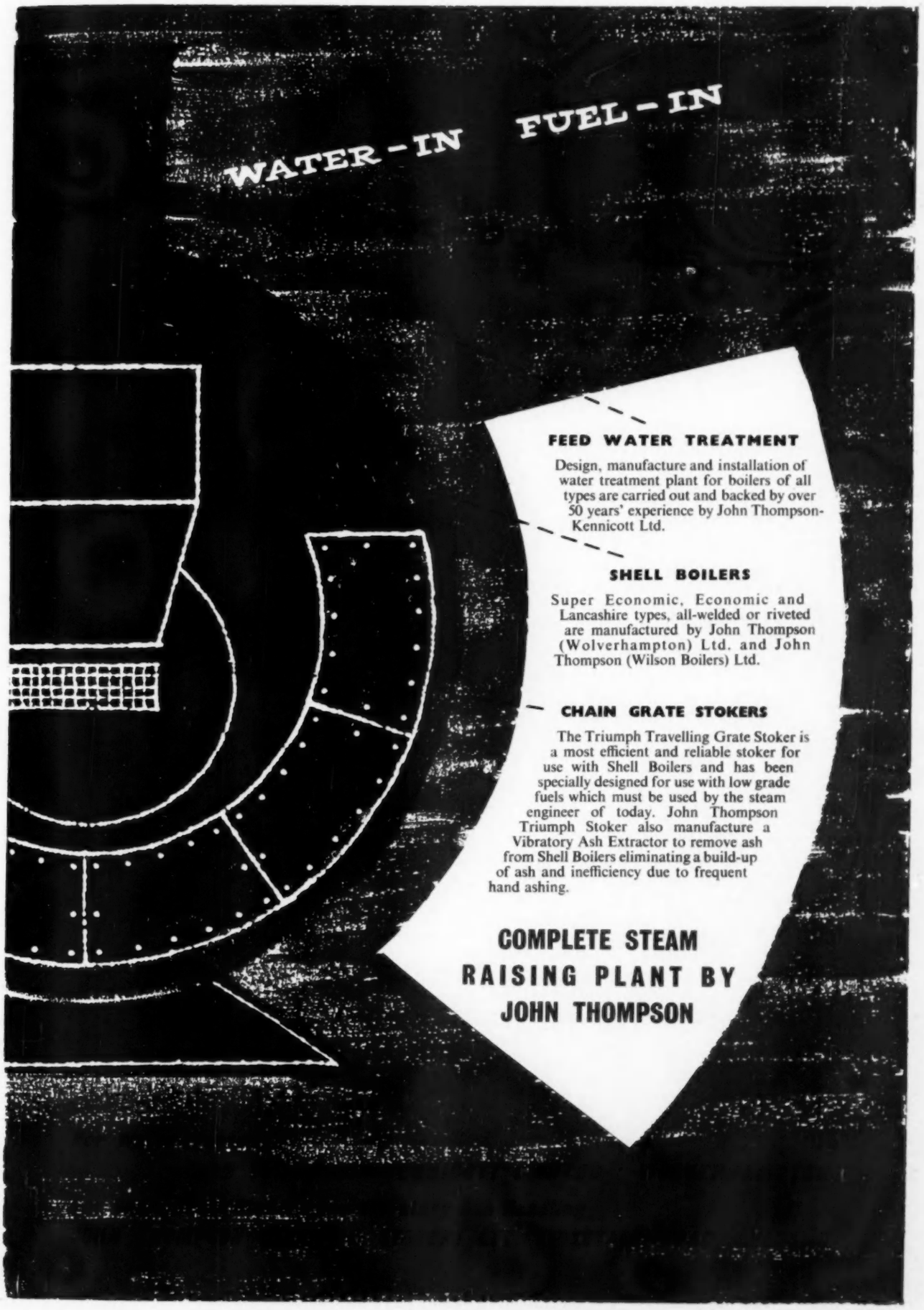

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